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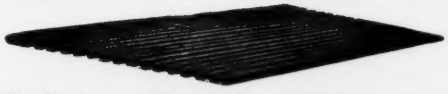

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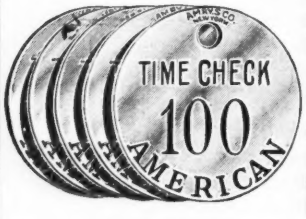

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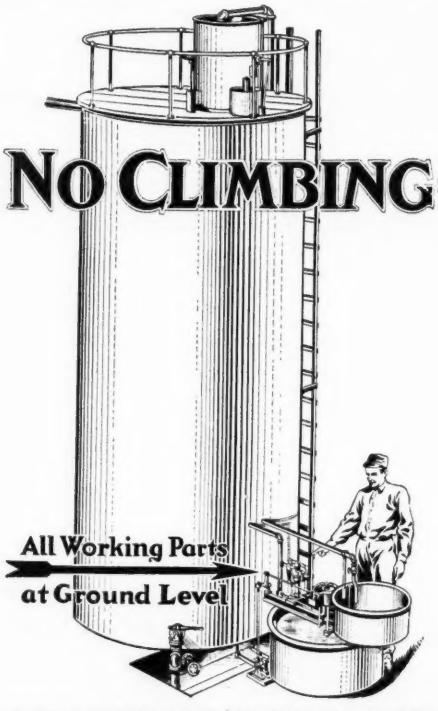

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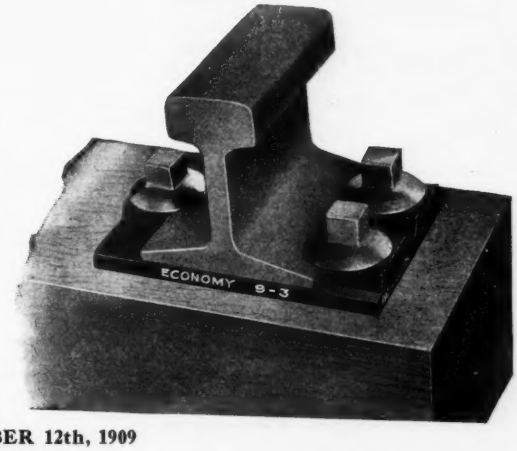

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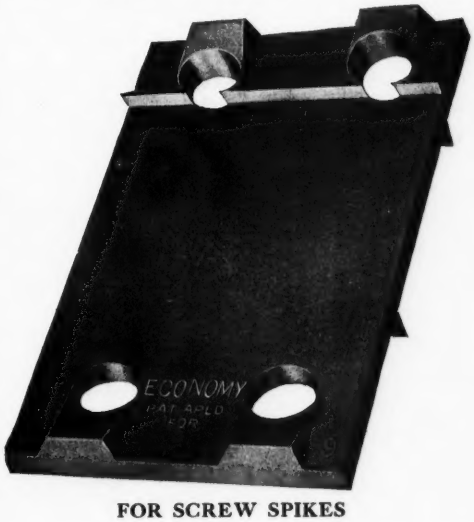

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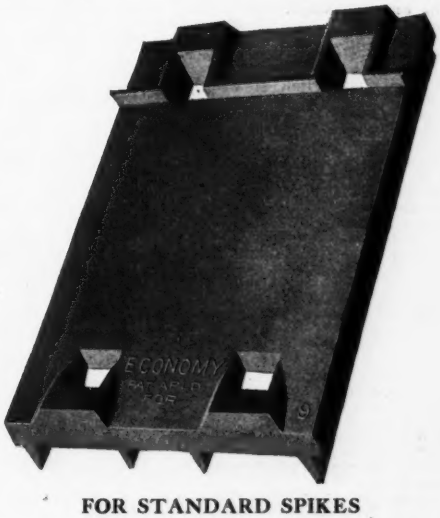

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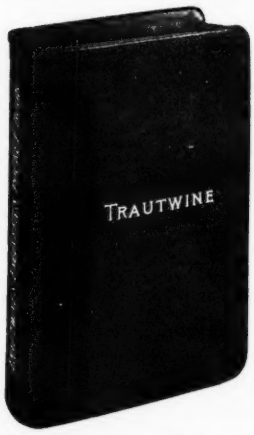

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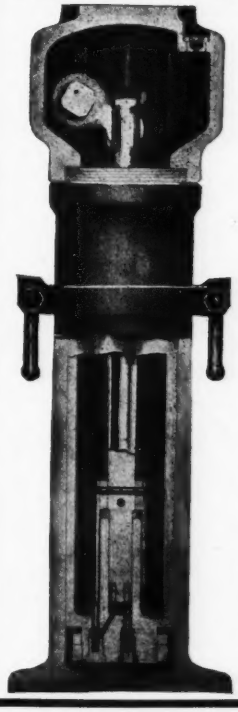

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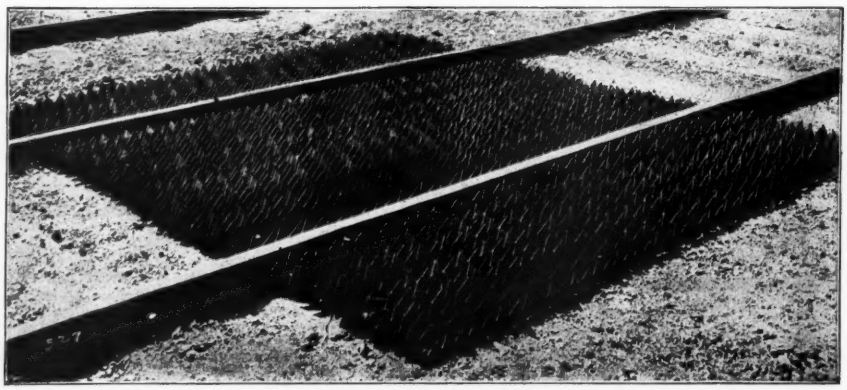

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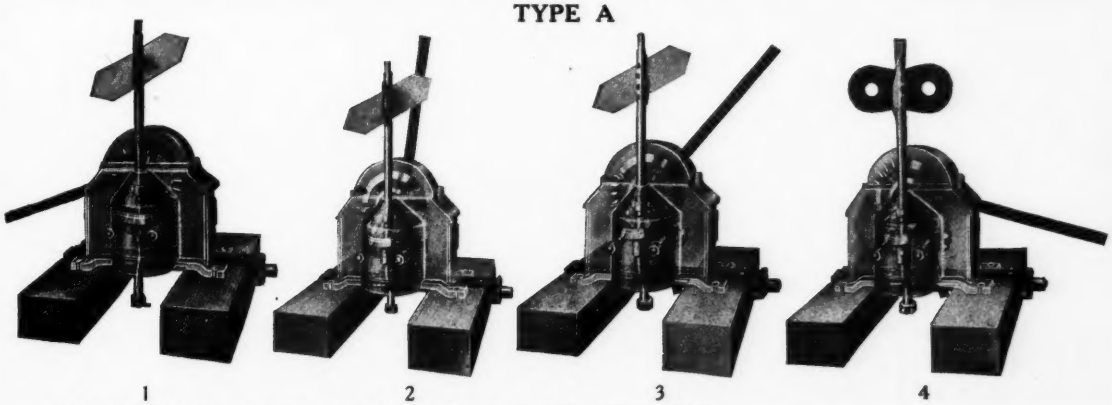

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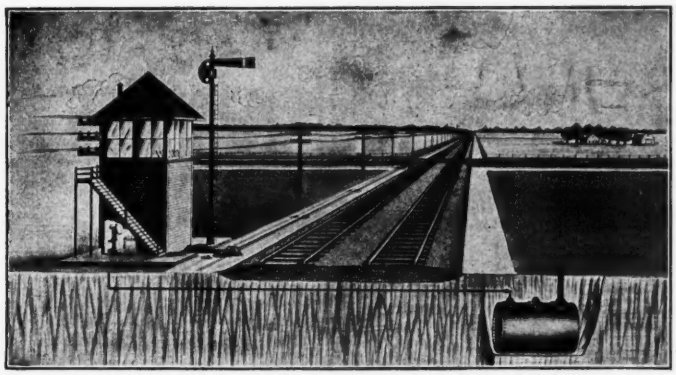

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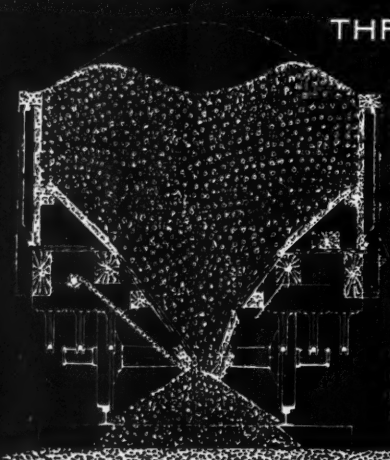

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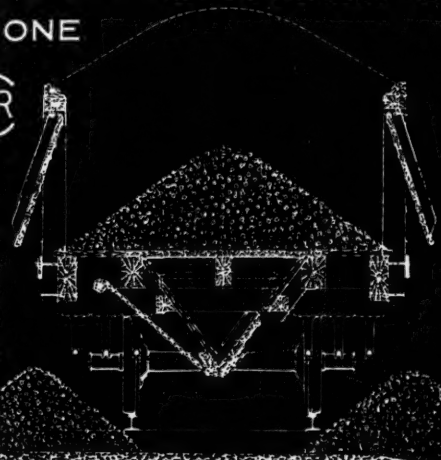

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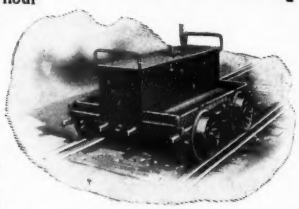

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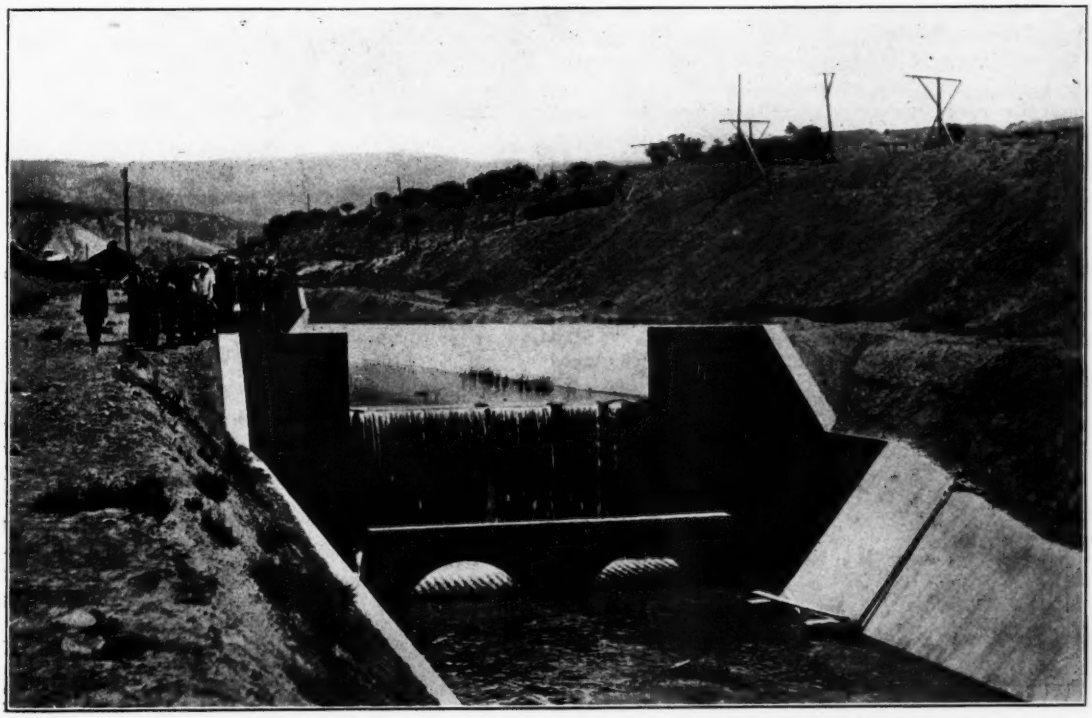
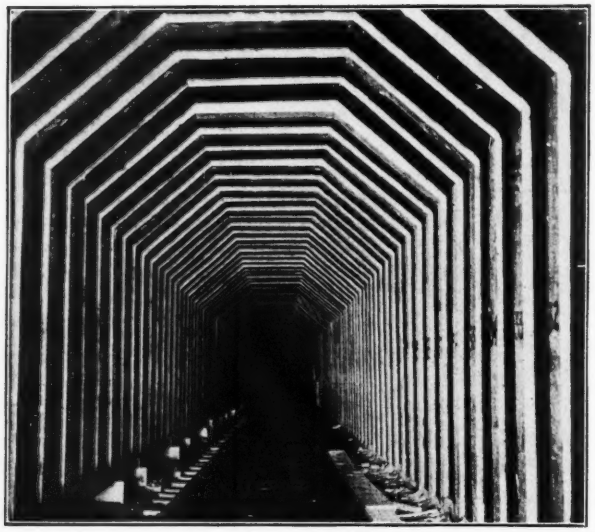
The Gunnison Irrigation Tunnel

When President Taft, on September 23, formally opened the Gunnison irrigation tunnel in Colorado, the act marked the substantial completion of the most difficult, from an engineering standpoint, of the some thirty reclamation projects which the United States government now has in hand. The country which will receive the benefits of the flow from the Gunnison river by way of the six-mile tunnel through one of the ranges of the Rocky Mountains is the fertile but semi-arid valley of the Uncompahgre river. This covers about 150,000 acres of land suitable for a variety of agricultural productions and needs only a more dependable source of water supply than the Uncompahgre which in spring time is a rushing torrent but the most of the rest of the year is in the condition of having been sucked up into the dry atmosphere until the stream is not much more than visible to the unassisted eye. The Gunnison river is a running stream of large volume and its valley and that of the Uncompahgre lie parallel to each other for some thirty miles with the mountain range between. The tunnel, which is the principal feature of the whole project, forms the connecting link. It will make the situation plainer if the mountain range is imagined as the cross section of an immense saw-tooth with its vertical edge toward the Gunnison canyon and its inclined back towards the Uncompahgre valley.

The Gunnison river runs through a deep canyon with walls so precipitous that its banks are inaccessible in but a few places, even on foot. The elevation of the river bed is about 6,000 feet above the sea level and the mountain ridge is about 3,000 feet higher. The opening of the tunnel at the river end is seven feet below ordinary low water level to insure a permanency of supply at all seasons whatever the stage of the water in the river. From this point the passage runs for 30,582 feet on a uniform grade of 2.02 feet per thousand to the west portal. Beyond the west portal the waterway is continued in a con-



Gunnison Tunnel, Showing One of the Concrete Drops on Canal Leading from West Portal.



Timbered Section Gunnison Tunnel Before Lining with Concrete

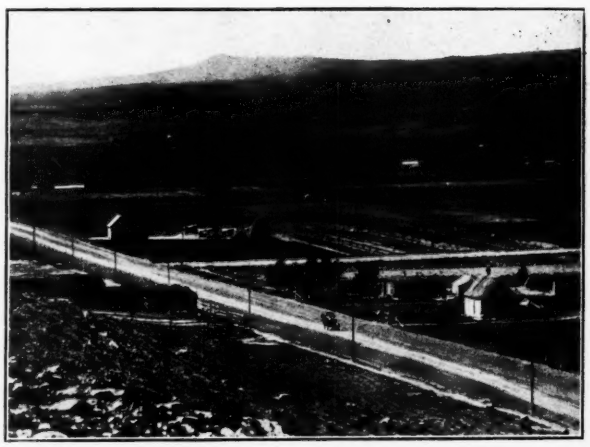
crete-lined canal 30 feet wide at the bottom, 83 feet wide at the top, in which it is calculated that an average depth of water of ten feet will be maintained. The tunnel itself is ten feet wide on the floor with walls battering outwardly to a width of 11 feet at a height of ten feet, and the roof is an arch having a rise of two and one-half feet. The flow capacity is calculated to be 1,300 cubic feet per second. When entirely completed the tunnel will be lined throughout with concrete. Up to the date of the opening there still remained about 10,000 feet on which the opening has been cut to a height of only eight feet. This is calculated to be sufficient to supply immediate demands for water. The remaining work of cutting and lining will be completed in the winter season when water is not required for irrigation purposes and when the heat encountered may be less of a hindrance than it has been heretofore.

About every variety of difficult material to work known to tunnel engineers was encountered in the passage through the mountain, and many of them appeared with startling unexpectedness. It is not wholly anomalous that after a start was once made the most satisfactory material to work was found at the east end. Here the formation of the mountain may be conceived to have retained its original solid rock condition, but toward the west, where in the progress of ages the mountain side has slumped away, all sorts of fissures, faults, cavities and mixed materials, solid, liquid and gaseous, occurred in a way to form what the government engineer in charge of the work characterized as "a geological fault zone which furnished a weird and unholy assortment of grief."

East Portal of Gunnison Tunnel

For about 15,000 feet from the eastern portal the material encountered was metamorphic granite which held its place so well that only about 3,000 feet required timbering to prevent caving. Then came a fault zone of about 2,000 feet. This zone was characterized by high temperature, pockets of hot water, carbonic acid gas, coal and soft limestone. Next followed a stretch of about 10,000 feet of shale with pockets of combustible gas and about 1,200 feet along the plane of union of strata of shale below and gravel above in which occasional sand-slides buried tools and track for several hundred feet from the heading. In this zone also considerable volumes of water poured from deposits above causing the disappearance of several springs and lakes from the sides of the mountain. From this stretch to the western portal the material was clay, sand and gravel, singly or in combination.

For the alignment of the tunnel and in order to enable the work to be carried on from four headings at once, a main shaft was sunk about 5,000 feet from the west portal. This is 263 feet deep and five by ten feet in cross section . This enabled the engineers to get a base line nine feet long at the bottom of the shaft and the location of the line of the tunnel on the surface



Cultivated Land in Vicinity of No. 1

was projected to the bottom of the shaft by means of 12-lb. plumb bobs suspended on piano wire. A curious fact is that on account of air currents, magnetic attraction acting on the wires, or something else, the plumb bobs could never be brought to a state of absolute rest to enable them to be used to determine the points upon which to use the transit in laying off the line of the tunnel. The engineers finally adopted the expedient of treating the plumb bobs and lines as pendulums, observing the extent of their vibrations and then calculating a mean, which evidently would correspond with the surveyed line at the upper end of the shaft. This method finally resulted in securing a line so accurate that meeting points between the several headings came within a small fraction of error.

It became necessary later on to sink another shaft about 4,000 feet further on from the west portal for purposes of ventilation. This was in the zone of high temperature and carbonic acid gas. Connection between this shaft and the headings was made by a line of 16-inch pipe which was used alternately for exhausting the hot, foul air and for blowing in a supply of fresh, cool air.

Power was taken from two plants, one at each portal. The two were substantially similar in equipment, but on account of

its accessibility the plant at the west portal included repair shops, supply depot, quarters for the men, etc. This location is easy of access from the Denver & Rio Grande Railroad, which runs the length of the Uncompahgre valley. To reach the east portal it was necessary to construct a wagon road ten miles lond and at an expense of $25,000. On this road the best grade that could be obtained against load was a maximum of six per cent, and the grade on the east end descending into the canyon was from 12 to 23 per cent. Of course, all loads went into the canyon, the teams returning empty. Average loads of 1,000 pounds were hauled by teams of four or six horses. They made one round trip a day and the cost of hauling was about 45 cents per ton-mile. The road ascended 2,000 feet in 6¾ miles and descended the same amount in 3¼ miles.

The power plant at the east portal had boilers of 320 h. p. in four units; three air compressors of a total capacity of 2,300 cubic feet of free air per minute; three electric generators of a total capacity of 225 kilowatts, 250-volt direct current; two cycloidal blowers having 20-inch outlet and operating against a pressure of two pounds per square inch, used as a vacuum producer to withdraw foul air from the tunnel. Their capacity is about 6,000 feet of free air per minute.

For hauling in the tunnel electric locomotives of six tons weight were used. These developed a drawbar pull of 2,400 pounds at a speed of six to eight miles per hour. At the west end the cars used were of the side dump pattern of 35 cubic feet capacity. At the east end it was found desirable to use a non-dumping car of 54 cubic feet capacity with wheels rigidly attached so that it could be picked up bodily by a derrick and dumped. On account of the small volume of material to be handled at this end the dumping could be readily taken care of by the tramway crews.

Some reference has been made to the difficulties encountered in certain sections of the work. Water was the source of the greatest trouble. On account of the down grade from east to west all water accumulating at the east end must be removed by pumping. At one time a flow of 1,500,000 gallons per day was encountered and at another a stream of water stopped all work at that heading for six months. At the west end, when a flow of carbonic acid gas was struck, about 12,000 feet from the portal, the heat was so intense that work was impossible until ventilating apparatus was installed, including the sinking of the ventilating shaft before mentioned. At an expense of several months labor, blowing apparatus capable of handling 12,000 cubic feet of free air per minute was installed. Later

Cement Line Chute, Gunnison Tunnel

Wild Land to Be Irrigated by Gunnison Tunnel

on, rushes of water were encountered and so much care had to be exercised and so much time was consumed in digging out buried track and tools from the sand that an advance of 50 feet in a month was considered fair progress. The average rate of progress, however, notwithstanding the obstacles, was 566 feet per month, and some records were made.

The headings were brought together on July 6. The project has been under consideration for 20 years and a beginning was made by the state of Colorado in 1901. This was very soon abandoned and the work was taken up by the federal govern ment in 1905 under the national reclamation act. The cost of the tunnel and the canal which forms the main artery of distribution is estimated at $5,000,000, and for this outlay the government expects to be reimbursed by the sale of land and power privileges at such rates that the aggregate will cover the entire outlay, and still make the cost to the individual purchaser hardly more than nominal.

The work has been in charge of Mr. I. W. McConnell, supervising engineer United States Reclamation Service. The photographs from which the accompanying engravings were made were furnished by the courtesy of the passenger department of the Denver & Rio Grande Railroad. The lands to be irrigated are said to be suitable for fruit-growing and for the raising of nearly all kinds of farm crops. After leaving the tunnel the water will have a fall of 372 feet and can be utilized to generate sufficient electric current to supply the needs of the whole valley for lighting and industrial purposes.

Grade Crossings

In furtherance of its policy of invariably avoiding grade crossings in all new and revised constuction work, and of elminating as rapidly as possible such crossings as are considered dangerous, the Pennsylvania Railroad, in making improvements on its Main Line between Altoona and Pittsburg, will eliminate six crossings at highways over which there is heavy travel.

Work to be done at Greensburg, Pa., includes the removal of a tunnel, a change of grade, and the elimination of one grade crossing. In view of the large number of employes of the Cambria Steel Company who use the Station street grade crossing at Johnstown, an overhead bridge is to be constructed at that point and an undergrade tunnel for pedestrians will be built just west of the passenger station.

Locomotive and Car Repair Shops, New Orleans Great Northern R. R., at Bogalusa, La.

The accompanying photographic reproductions and drawings illustrate, in an unusually comprehensive manner, one of the neatest of the smaller class of railroad repair shops of modern times.

The New Orleans Great Northern R. R. is a new Southern railroad, the main line of which extends from Jackson, Miss. to the city of New Orleans, La. The road passes through an extensive undeveloped section of pine forests in these states commonly known as the "Ozone Belt." The present operating mileage is about 273, including the branch lines over which passenger and freight service is being maintained. The rapid growth of the traffic developed immediately demanded adequate provision being made for proper maintenance of rolling stock. Mr. C. W. Goodyear, Buffalo, N. Y., president; Mr. A. C. Goodyear, Buffalo, N. Y., third vice-president; Mr. N. C. Pearsall, Bogalusa, La., general manager, and Mr. J. F. Coleman, New Orleans, La., chief engineer, were the officials of the railroad company directly interested in the development of shop facilities and who passed upon the plans and had general supervision over the construction work. Mr. H. W. Burkheimer has recently been appointed master mechanic and now has charge of the shops and equipment.

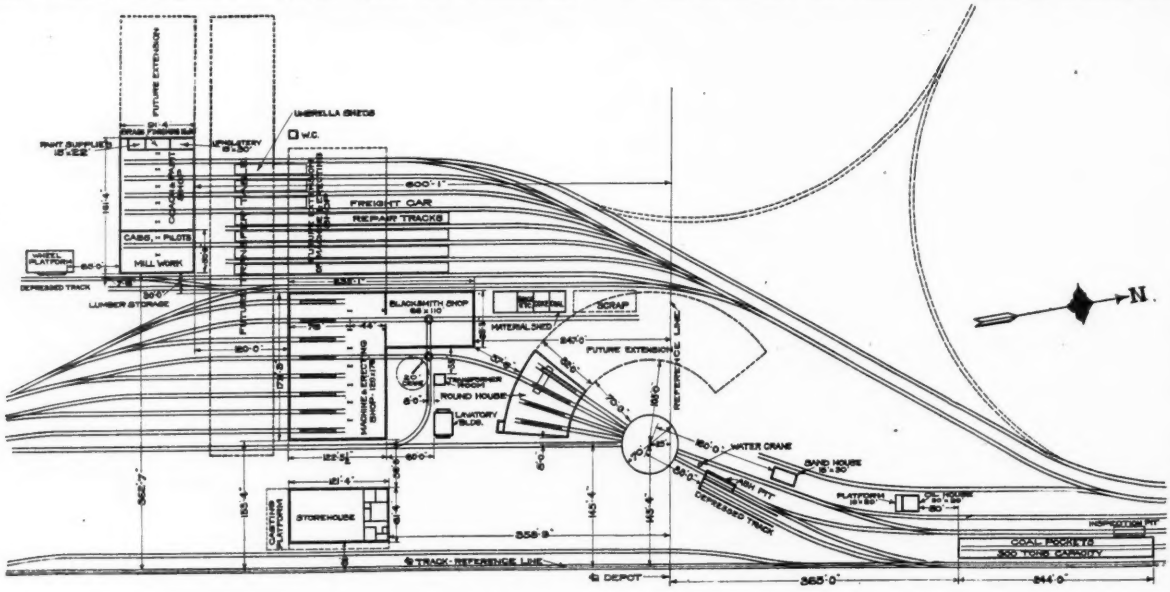
In February, 1907, The Arnold Company was requested to make a study of the conditions and requirements pertaining to locomotive, freight and passenger car repair shops. They were later retained as engineers to prepare plans and specifications for the buildings and equipment, and shortly after as constructors of the complete plant ready for service. Actual surveys and construction work on the shop buildings was begun in August, 1907, and actively progressed until December, 1907, when operations were suspended on account of the general depression in railroad business caused by the financial stringency throughout the country.

With the return of activity in the traffic department of the railroad the completion of the shops became necessary in order to meet the demands of increasing business and The Arnold Company was therefore instructed to resume work and push to as prompt completion of the shops as possible. The work was taken up in January and completed in June, 1909, the railroad company's respective departments occupying their new quarters during the same month.

View of the Bogalusa Shops, N. O. G. N. R. R.

The site chosen for the location of the shops at Bogalusa on the main line of the road, 70 miles north of Now Orleans, was deemed particularly suitable for the following reasons:

1. Its nearness to the center of gravity of the system.
2. The prospective development of the new city promising to attract a class of skilled and common labor well suited to the requirements of railroad work.
3. The available area of level ground adjacent to the main line, affording an ideal space for shop track system, with ample provision for future extension of each department.
4. The convenience and economy of purchasing electric power



General Layout of Bogalusa Shops, N. O. G. N. R. R.

for the plant from the large plant of the Great Southern Lumber Co., adjacent to the shop site, thus saving the railroad company the expense of building and maintaining a plant of their own.

5. An abundant supply of pure artesian flowing well water and excellent natural drainage.

6. A healthful spot for the employes, due to its elevation and proximity to the forests.

The locomotive and car repair departments are designed not only to accommodate the locomotive passenger and freight car equipment of the New Orleans Great Northern R. R., but provision is made for repairing and maintaining a portion of the special logging machinery of The Great Southern Lumber Co., comprising locomotives, steam log rollers, steam skidding machines and cars. The plant is designed with present facilities for handling 50 locomotives of American standard type; 20 geared locomotives; 10 steam log loading and skidding machines, and 5 Barnhardt steam log loaders. In addition to the above there are provided repair facilities for taking care of approximately 3,000 freight and logging cars and 30 passengers cars.

For the accommodation of the several shop departments there are provided five main buildings and seven auxiliary structures, the main buildings comprising locomotive shop, which includes erecting, machine, forge and boiler and tank departments, the coach shop, which includes the woodworking shop, the engine house, general storehouse and office building, and the locomotive coaling plant. In addition to the above main buildings there is an oil storage house, lavatory buildings, transformer house for electric service, material storage building, cinder and ash pit and depressed car wheel handling pit. By referring to the block plan, it will be noted that the layout is designed to provide for the necessary terminal facilities as well as those for general repairs.

View Showing Nature of Ground on Shop Site

The shops are located directly opposite the passenger station, which renders convenient the local inspection of through passenger equipment while such trains are stopping at the depot. The north end of the property is devoted to terminal purposes, locomotives coming onto the turntable pass directly over the cinder pit and leave the roundhouse by way of the water crane, sand house, oil house and coal pockets. The coal pockets are arranged with two aprons on each side, permitting locomotives to be coaled either on the main line or from the siding.

Shop Track System.

The yards and buildings are served with a convenient system of standard guage tracks, and each department is laid out to permit of 100 per cent extension without encroaching on territory intended for other uses. The locomotives and coach shops are at present approached by means of a system of ladder tracks, the plan being to remove these tracks whenever the shops are extended, and install a transfer table running between the two buildings. This table will serve for the transfer of material as well as for entrance purposes of engines and cars. The freight car repair shops are located north of the coach shop, convenient to the woodworking shop and lumber storage piles, and also well situated with reference to the forge and locomotive shops. A standard gauge track passes through the woodworking shop and runs parallel with the freight car repair tracks, which serves as an industrial track for transporting timber from the mill to the repair yard. A standard gauge industrial track is provided through the locomotive and forge shop, passing the material sheds and scrap storage yard, which greatly facilitates the handling of material between these departments. A track directly through the machine shop and engine house passes over the driving wheel drop pit and renders it possible to roll removed drivers directly from the pit into the machine shop, where they can be taken with an electric Telpher hoist from this track direct to the driving wheel lathe. A Y track is provided in the north end of the yard for turning coaches and cars which are too long to be turned on the turntable.

The turntable is of the "deck" type, 70 feet in length, and has a capacity of 180 tons, being at present operated by hand. The circular pit is constructed of concrete with a finished floor sloping toward the center to a catch basin, connected to the yard sewer system.

General Description of Buildings.

The buildings in general have walls constructed from the foundation up of reinforced concrete, made from washed creek gravel. An abundant supply of gravel and sand extremely adaptable to concrete construction, was obtained from Bogue Luse creek, immediately adjacent to the building site. The gravel and sand, being clean and white, give a pleasing color to the concrete; the buildings presenting a very attractive appearance. All walls are carefully reinforced with steel bars, the walls in general being eight inches thick. The window and door frames were placed in the concrete forms and the walls cast around them, thus insuring a good anchorage and neat joints. An impression made upon the observer is the solidity and durability of the construction, which is semi-fireproof throughout. The substantial construction of the buildings and the ample provision of the faith of the railroad company in the future growth, for expansion, which is apparent in the layout, is indicative development and extension of the business, and of their foresight in outlining these details.

Locomotive Shop.

The locomotive shop is 176 feet long by 120 feet wide, with a wing at the west end of 66 feet by 110 feet, which is occupied by the forge shop. It is of the transverse type; the erecting bay is 75 feet wide, 37 feet clear under roof truss, and has eight concrete engine pits on 22 foot centers. The machine bay is 44 feet in width and extends the entire length of the building, adjacent to the erecting bay. The building superstructure is of reinforced concrete and steel construction and has a corrugated muck bar iron roof. The floor is of 3-inch yellow pine laid on 4x6 sleepers embedded in sand. The steel columns are designed to support a future 100-ton crane runway, with traveling crane over the erecting bay. For the present needs a 5-ton traveling hoist on bracket runway is provided on the north side of the bay.

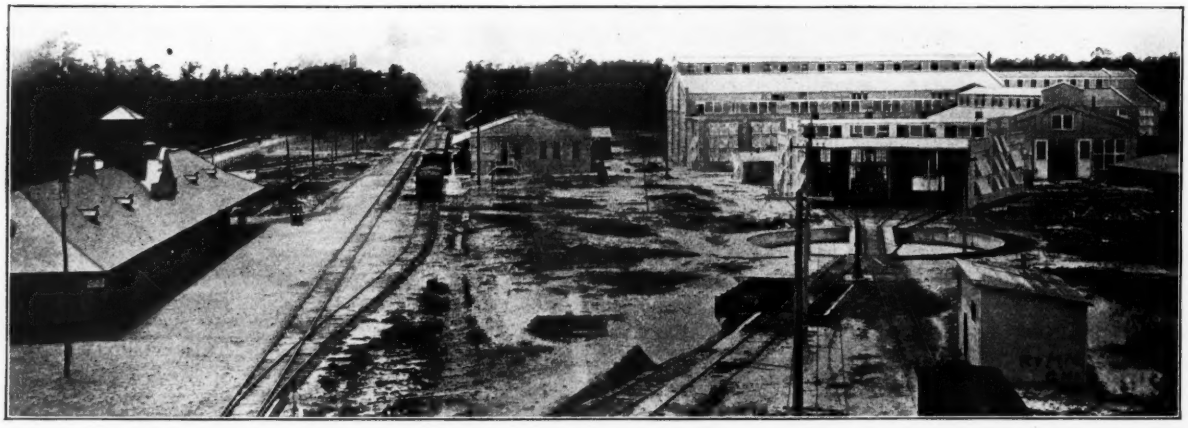
Particular attention was given to the natural lighting of the building, and, in addition, to the side windows and transoms over the track doors. More than one-third the area of the doors is glass. The erecting bay has a wide monitor with windows on each side over its entire length, and the machine bay is lighted by three sawtooth skylights, which extend the length of the building, excepting the last bent on each end, and which shop by an eight-inch concrete fire wall, having an automatic fire door.

Coach Shop.

The coach shop, 161 feet long by 91 feet wide, is of reinforced concrete construction, having wood roof framing covered with corrugated iron. As in the other buildings all possible natural lighting and ventilation are provided, the windows being operated in a manner similar to those in the locomotive shop.

Track doors on both sides of the building provide for additional ventilation and render it possible to use all tracks as through tracks at some future date if desired. The section devoted to woodworking machinery is 50 feet wide by 91 feet long and is separated from the coach department by an eight-inch concrete fire wall and two double automatic fire doors. A full complement of woodworking tools are arranged on either side of the track leading to the freight car repair yards.

In the west 20 feet of the building are located the brass finishing, upholstering, paint storage and bench workrooms, separated from the main section of the building by an eight-inch fire wall and from each other by eight-inch walls 12 feet high. Each room has an outside door and a double automatic fire door leading into the coach room.



Station and Roundhouse, Bogulusa

furnish excellent north light for the operation of the machine tools.

On account of the heat and humidity of the climate, the windows are designed to provide for all possible ventilation and are equipped with mechanical operators. The majority of the side windows are hinged at the top, and arranged to swing outward by means of vertical gang operators, giving an opening of about 30 per cent of the window area.

The monitor windows of both the erecting and forge shop are also arranged to open, the sash sliding past each other and giving an opening of about 50 per cent of the window area. These windows are moved by a steel cable controlled by a geared operating device. As a still further means of ventilation over the machine bay the sawtooth monitors are provided with circular metal ventilators distributed throughout their length.

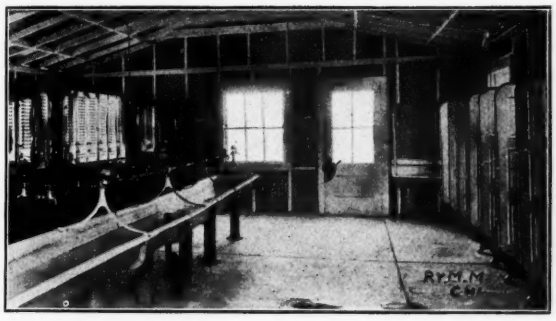
The tool room, 21 feet square, is in the wing occupied by the forge shop, and is separated from the forge shop by an eight-inch concrete wall, and connected with the machine shop by a double door and two windows fitted with diamond wire mesh panels.

The forge shop has concrete walls, steel columns and roof trusses and a corrugated iron roof; also a six-inch floor of tamped screened cinders, and is separated from the machine

The main central portion of the building, 90 feet long by 90 feet wide, is used for coach repairs and painting, and is provided with four tracks on 20-foot centers. The floor in this building is of three-inch yellow pine laid on 4x6-inch sleepers embedded in sand.

The engine house is provided with four stalls and concrete engine pits, two of which are connected by a driving wheel drop pit, in which wheels are handled by means of a traveling pneumatic jack of the telescoping type. The building is of reinforced concrete construction, uniform with the shop buildings, and has wood roof framing and a tar and gravel composition roof. The sheathing is two-inch matched yellow pine and the purlins and framing are sufficiently heavy to provide a "slow-burning" type of construction. The smoke jacks are vitribestos, of ample dimensions, and are suspended from the purlins by means of heavy iron rods well painted with asphaltum paint. The usual track doors on the inner circle of the building are omitted, a three-foot wide canopy affording necessary protection from the weather. The floor is of three-inch yellow pine to the end of the engine pits, to which point the tamped cinder fill between the turntable and the engine house extends.

The ventilation and lighting of the house is well provided for in a wide central monitor, both exposures of which are arranged to be thrown open, and in large areas of rear and side wall windows, with all hinged sash operated mechanically; thus



Lavatories, Bogalusa Shops

practically every foot of window and door area, under ordinary circumstances, aids in insuring free circulation of outside air throughout the building. An annex 12x16 feet is provided for the foreman's office in a convenient location.

Store House and Offices.

The storehouse and office building, 121 feet 4 inches long by 61 feet 4 inches wide, is of reinforced concrete and "slow burning" wood construction, with a corrugated iron roof. The north 30 feet of this building is divided into suitable rooms designed for the offices of master mechanic, clerks and storekeeper, and store rooms for stationery and supplies. The remainder of the building is used for the storage and handling of general supplies required in the operation and maintenance of the road. Storage bins, shelves and material racks are provided for this purpose. The store house floor is four feet above rails of serving track for convenience in loading and unloading cars. The floor, consisting of three-inch plank secured to 6x6-inch stringers embedded in cinders, rests on an earth fill within the foundation walls. A wooden platform, supported on concrete piers, extends the full length of the building on the east side, parallel to the side track, and has an incline or ramp to grade at each end for the purpose of trucking heavy material. A canopy over this platform affords protection from the weather for the men loading and unloading cars.

Coaling Plant.

The coaling plant is a wood structure with steel lined bunkers, having a storage capacity of 300 tons. Standard coal dump cars are pulled up a trestle, having a 20% grade, on to a track 36 feet above the main line, directly over the bunkers, by means of an electrically operated hoist, power being supplied by a 40 horse power induction motor. This hoist is of sufficient capacity to pull a loaded coal car weighing 150,000 lbs. up the 20% grade at a speed of 30 feet per minute. The bunkers are equipped with four steel aprons and gates, two on a side, permitting coal to be loaded by gravity directly into the locomotive tenders on either side. A wood canopy covers the bunkers and hoisting machinery, the latter being housed on three sides to give protection to the hoisting machinery.

Exterior of Erecting Shop

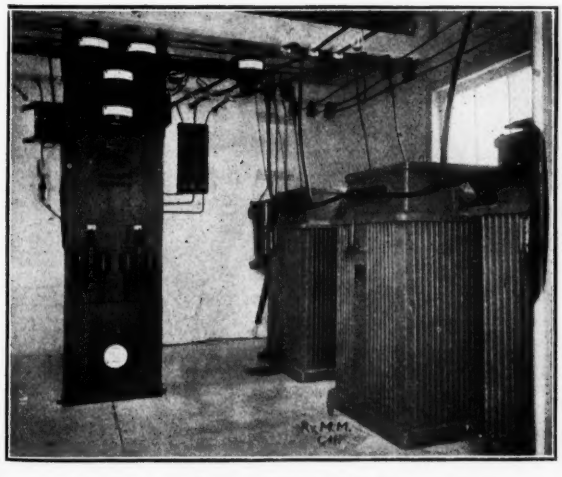
Auxiliary Building.

The oil house is located adjacent to the track used for outgoing locomotives and is 20 feet square, being built of corrugated iron on a wood frame work. The oil storage tanks are of reinforced concrete lined with sheet metal, the top of the tanks forming the floor of the delivery and waste storage room. The five tanks have a total capacity of 23,000 gallons, and each is provided with a rotary hand pump and galvanized iron sink. The tanks are filled through manholes in the concrete tops.

The sand house is a frame structure, 15 feet by 30 feet, sheathed with drop siding and covered with a composition roof. Wet and dry sand storage bins are provided, and also elevated platform and door, from which a man can step directly onto the running board of an engine.

The employes' lavatory, 24 feet by 32 feet, is a corrugated iron building located between the locomotive shop and the engine house, convenient to all departments. The lavatory building has a concrete floor sloping to a bell trap near the center of the room to permit flushing with a hose. The room is equipped with 100 perforated sheet steel clothes lockers; a 20 ft. automatic range closet; a 20 ft. porcelain enameled iron wash sink, and two 4 ft. enameled urinals.

The transformer house, 16 feet square inside by 9 feet high, is fireproof, having reinforced concrete walls, steel channel purlins and a corrugated iron roof. The concrete floor is raised 12 inches above grade to avoid dampness and is laid on a cinder



Transformer Room

H. W. Burkheimer, Master Mechanic, Bogalusa Shops

Coaling Station, Bogalusa Shops

substructure. A wood frame work of seasoned yellow pine is set in the building walls for supporting the wires and cables.

Machine Tool Equipment.

The machine tool equipment is ample to meet all present requirements, as well as to provide for some future increase of business, the layout being so designed that work shall pass through the shops with a minimum of handling.

The machine and boiler shop tools are divided into three groups, each group being driven by a 40 horse power induction motor mounted on a steel bracket, supported by a building column. The main line shaft is so arranged that any motor may be out of service and yet the important tools may be operated by coupling its section of the main line shaft to adjacent sections driven by the other motors. The west group includes the lathes, driving wheel press, shaper, milling machine and drill presses. The middle group includes the planers, boring mill, slotter, grinders, etc., and the east group comprises boiler and tank shop machinery, including pressure pump for the water system.

The toolmaker's lathe and grinding machinery in the tool room are driven by a 5 horse power motor mounted on wall bracket, and, in case of necessity, the tool room lineshafting can be coupled to that in the forge shop and these tools driven by a forge shop motor. Jib cranes are liberally provided for use in stripping and assembling locomotives undergoing repairs. The heavier machine tools are likewise served by similar cranes, ranging in capacity from one to four tons. These cranes were furnished by the Whiting Foundry Equipment Co., each being fitted with a Yale & Towne chain hoist. Running lengthwise of the erecting bay and near the machine boy is located the floor-controlled electric traveling hoist of 5 tons capacity, equipped with three phase induction motors operating at 460 volts. This hoist handles principally the driving wheel work between the various pits and the wheel lathe, but, in addition, it serves for general transportation of heavy material.

In the southeast corner of the woodworking shop is located the tools required for car wheel work, such as hydraulic wheel press, double head axle lathe and car wheel borer, the wheel presses being directly opposite the wheel storage platform located just outside of the building. A depressed wheel pit for loading and unloading mounted wheels is located adjacent to the wheel platform.

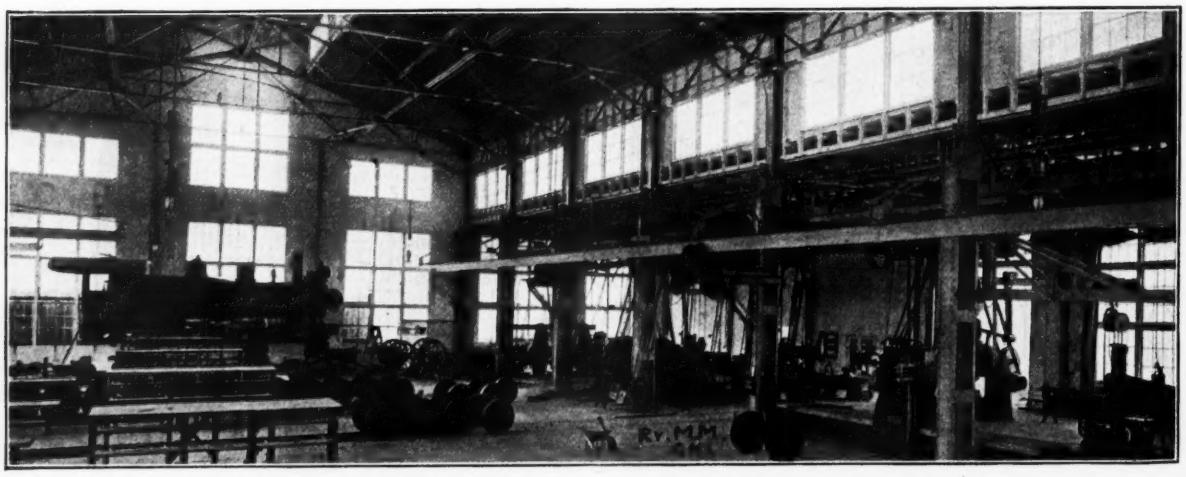
The woodworking machinery is divided into two independent groups, each operated by a 40 horse power induction motor mounted on overhead platform. The shafting in this building is supported by 4 in. by 12 in. latticed wood struts fastened to the bottom chord of the roof trusses, and at the ends set into the concrete end and partition walls.

The forge shop tools consist of power hammer, bolt header and flue machinery, together with forge blower, driven by a 30 horse power induction motor mounted on a steel and concrete bracket. In addition to 11 forges, the blower furnishes heat for furnaces used with hammer, bolt header and flues. All blast ducts are laid underground in salt glazed sewer tile. Power hammer, furnaces and forges are served by two Whiting 4-ton post cranes conveniently located.

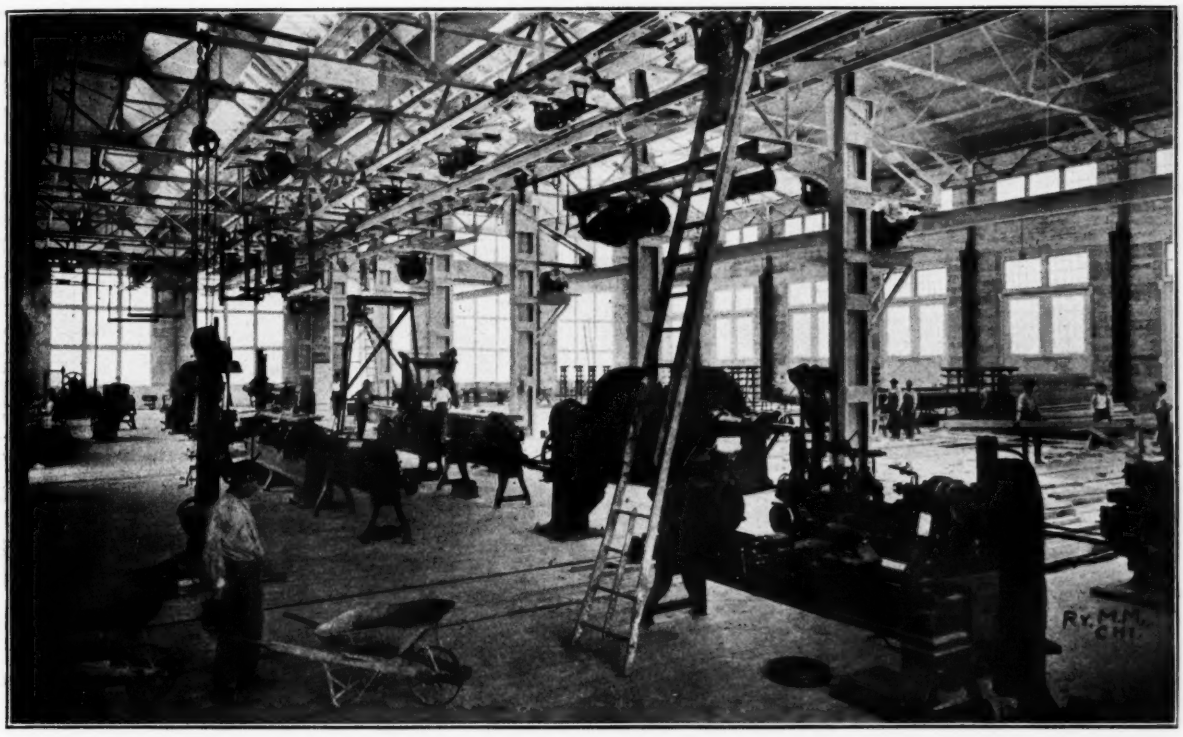
One No. 50 (36 in.) Fay & Egan band saw.
One No. 4 (18 in.) Fay & Egan wood lathe.
One 48x6 in. Pond grindstone.
One No. 6A Fox bench wood trimmer.

Power and Lighting System.

Electric power is purchased from the Great Southern Lumber Co., whose plant is located about one-half mile distant. The current is brought to the shops over a 2300-volt, three-phase, transmission line, consisting of three No. 4 bare copper wires carried on wood pins and crossarms on 7 in.



Locomotive Er ecting Shop



Machine Bay of Erecting Shop

top 40 ft. yellow pine poles. The primary circuit at the receiving substation is provided with lightning arresters, hook switches and choke coils, and is controlled by two separate automatic, overload release, oil switches (one for power and one for light) mounted on a slate panel. This panel is further equipped with integrating and indicating wattmeters; ammeters for each phase; voltmeter and power factor meter. The portion of power used by the motors and arc lamps is transformed from 2300 volts to 460 volts by means of three 75 kilowatt Westinghouse single phase transformers connected in delta. A three phase, 2300-110 volt transformer provides for the incandescent lights.

From the transformers the low tension wires are carried overhead to the distributing panels, located in the tool room, on which switches are mounted for controlling the lighting and power circuits throughout the buildings. On this panel there are also located a voltmeter and an ammeter, together with multiple point voltmeter and ammeter switches so connected that voltage and current readings may be made at will on any individual power or lighting circuit.

Allis-Chalmers three phase induction motors are used throughout, nine motors being installed at present, with an aggregate horse power of 325. Each of these motors is capable of carrying 25% overload for one hour and 50% overload momentarily. They are each controlled by a starting compensator, and are protected when starting by fuses, and when running, by both fuses and automatic circuit breakers provided with no voltage release coils.

There are 28 Western Electric, 460 volt, arc lamps installed throughout the yards and buildings; 14 of these being in the locomotive shop, 3 in the engine house and 11 in the yards. This type of lamp is used because of its convenience for operation on power circuits, thus simplifying the wiring system, as in many instances the lamps are remote from any lighting mains. These lamps are protected from short circuits by double-pole cutouts at connection to mains.

The arc lamps installed in the engine house are fitted with special tapped tops and threaded to conduit used as a hanger. All wiring is in conduit, an effort being made to make the installation proof against corrosion by fuel gases.

The remainder of the artificial shop lighting is by means of incandescent lamps used on drop cords and adjustable bench fixtures, a total of about 200 lamps being installed. Plug receptacles for extension cord lights are provided at numerous places in the locomotive shop and engine house, allowing any point in either building to be easily reached.

Water System.

Water for shop purposes is piped from the plant of the Great Southern Lumber Co., where fire pumps are installed in conection with an elevated tank. The ordinary pressure on the water service mains is 45 lbs. but this can be increased to 100 lbs. pressure in case of fire.

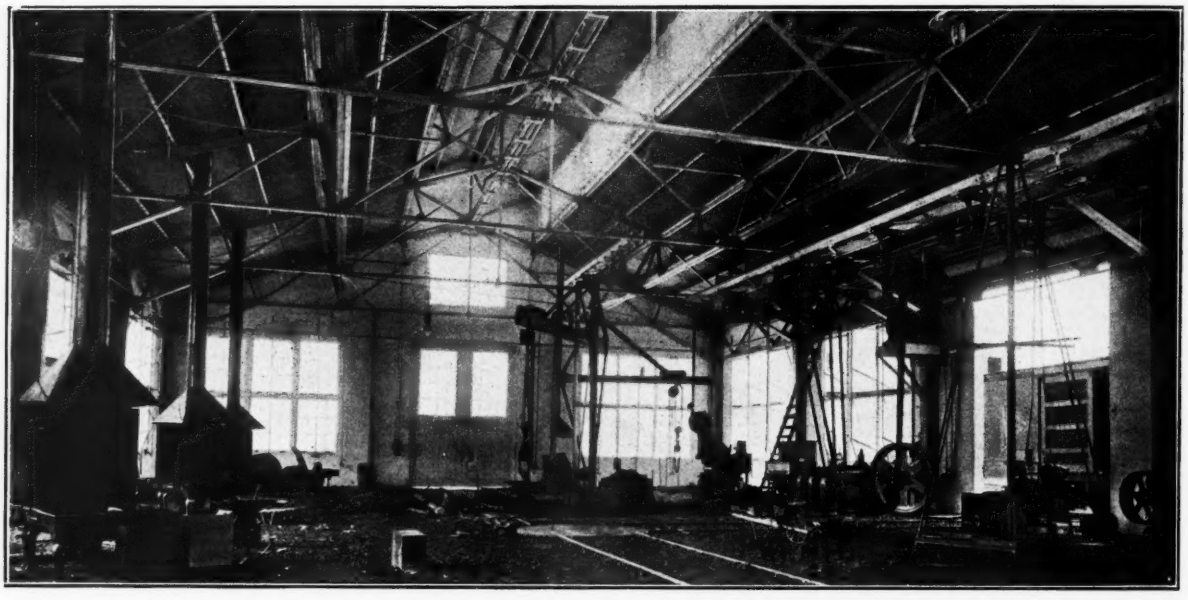
The shops have good fire protection facilities, the yards being supplied with a network of water mains of ample size with well located fire hydrants and hose valves. Distributed throughout the buildings are hose racks, each containing 50 feet of Underwriters' linen fire hose permanently attached to hose valves and each provided with a hose nozzle. With water at 100 lbs. pressure it is possible to reach any point of the buildings with two effective fire streams.

For boiler washing purposes a Deane triplex pump, of 225 gallons per minute capacity, was placed in the machine shop. This pump delivers water at 100 lbs. pressure to the hose valves in the engine house and to the engine pits in the erecting shop.

Drinking fountains are placed in convenient locations in the locomotive, forge and coach shops, and in the engine house.

Compressed Air Systems.

An Ingersoll-Rand air compressor of 275 cubic feet capacity, belt driven directly by a 50-horse power motor, furnishes compressed air for shop purposes. This compressor delivers air at 100 lbs. pressure into a storage reservoir supported on the roof trusses, from which point air is piped to valved air outlets throughout the locomotive shop, forge shop, coach shop and engine house, and also to air valves distributed among the freight car repair tracks.



Blacksmith Shop

Sewer System.

The storm sewer system, which empties into Bogue Lusa creek, near the south end of the railroad company's property, is designed to carry off roof drainage from buildings and drainage from turntable, cinder and wheel pits. The yard areas are taken care of by open drains. The storm sewer system is provided with concrete manholes, each fitted with a perforated cast iron curb and cover. The sanitary sewer from the lavatory building has a separate lead to the city sewer system.

A rather unusual feature of the shops in general is the attention which has been given to appearance and the harmonizing of the structural designs and color scheme with the carefully studied landscaping of the city of Bogalusa. The entire town, including buildings for all purposes, is an interesting result of what can be accomplished by an effort to please the eye, without in any way detracting from general utility. The shops, with their dark red metal roofs, light grey concrete walls, and white window trimmings, surrounded as they are by the deep green of the pine forest, present an appearance not often equaled.

The engineering and construction of the complete plant ready for occupancy, which was handled by The Arnold Company, was executed by Mr. A. R. Kipp, engineer in charge, and Mr. H. H. Dickinson, superintendent of construction. Mr. P. L. Battey, chief engineer, railway shops department, had general supervision over the work.

NOTE—We are indebted to Mr. P. L. Battey of the Arnold Co., Mr. H. G. Pearsall, Mr. W. C. Park, and Mr. H. W. Burkheimer, of the railroad company for unusual courtesies in connection with the preparation of this article.—Ed.

The Maintenance of Way Department

Relaying Rails

Editor, Railway Engineering:—

In relaying rails we distribute the rails from flat cars allowing them to drop to the shoulder of road bed places on embankments, we stick up a couple of bars in the ballast which prevents the rail from rolling down the embankment. We remove the spikes from old track, on three sides only, leaving the spikes in on the inside of rail on the "line" side of track. The bolts are all taken from the old rails, after they are removed from the track, by wrenches, except in cases where the bolt is so badly worn that the nut will not turn, in which case they are broken by spike maul and picked up for scrap. The unbolting of rails is done at a time when the crew would otherwise be idle for any reason.

In commencing to lay rails the new rails are set up on the ends of ties and bolted; on straight track we are not particular about the number of rails set up at a time. The spikes are drawn from three sides and the old rails are thrown out by bars, both rails on the same side of track and, when possible, on the inner side of curves, as in this way they do not interfere with the removing of the ties.

We use 15-ft. switch rail for connections, which is bolted on the end of the old rail where connection is made, the switch rail is fastened in place by a yoke or clamp made for the purpose and leaves the end of new rail so that as soon as connection is made the crew can go right along setting up the rails and bolting them, and the connection can be made at any time with but very little delay. New rails are all bolted when placed in the track, and, in a few days, are all gone over again by the crew and tightened, after which the section crews look after them.

For expansion shims we use the common wire nails which can be had in any size, to suit the temperature, the advantage in using these nails is: it is not necessary to remove them which, at times, is quite a difficult matter. Ties are immediately placed under the joints and the joints tamped. In relaying where "Bonzano" joints are used it is necessary to remove any tie that comes in contact with the center of joint before rails are placed.

My idea is, that the life of rails and not the cost of relaying of the rails is the first consideration.

Yours truly,

Maine. ROADMASTER.

Frogs, Switches and Cattle Guards

Editor, Railway Engineering:—

For main track service spring frogs are preferable, except at

points where one track may be used equally as much as the other, and speed of trains fast, rigid frogs are used.

Guard rails 12 feet in length, flange planed off on the inside, to allow spike to be driven between guard rail and stock rail, leaving flangeway of 1¾ inches. Guard rail is secured to stock rail by means of bolting at each end of guard rail with two bolts 1 inch in diameter and one bolt in the center cast rolled steel filling at each end of guard rail, which answers as foot guard protection, also filler in center bolt. By this means guard rail is at all times maintained in proper position. Gauge of track at frog should be maintained at accurate gauge 4 feet 8½ inches, even though it is found necessary to widen gauge as the local conditions may require in other parts of the track.

SWITCHES.

For frogs, angles No. 7 to 11, switch points 15 feet are used, for No. 6 frog and under, 11 ft. points are used and for other angles length of points are made to meet conditions. All bends shall be made accurately and with care, so as not to injure the material. It is desired that rails be bent cold. If heating rails is resorted to, it should be done in a manner so as not to injure it. Points shall fit stock rail through the planing.

SWITCH STANDS.

There should be no lost motion in parts. Should have an adjustable throw on the foot. Operating lever should work parallel with track, must be snow proof and throw not less than 4 inches. The connection between the throwing rod and the stand must be so arranged that it will be impossible to separate the throwing rod from the stand when the stand is set up in working position, and must be so arranged that it can be easily inspected. Target must not show clear signal for main track movement unless the points are up snug against the stock rail.

CATTLE GUARDS.

After having used many types of cattle guards, the company which I represent has adopted the wooden slat cattle guard. Slats are 2 inches by 4 inches by 8 feet and tapered to a point on top. Each cattle guard for single track is comprised of three sections, each section bolted together, and for additional tracks sections are made to fill the requirements. I find the wooden guards are better and more durable than iron or steel guards, as the brine from refrigerator cars soon destroys the usefulness of the metal guards.

Michigan. Yours truly, ROADMASTER.

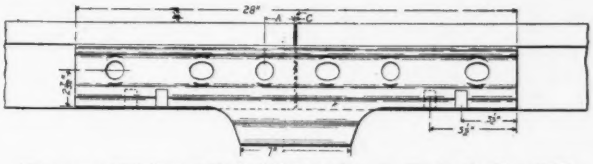
Rail Joints

Editor, Railway Engineering:—

The four hole bar is used on rail prior to the year 1907, since which time the six hole bar has been our standard, and this drilling is now used exclusively when laying new rail on main line tracks.

At the present time we are experimenting with and purchasing to a great extent the reinforced bars as exemplified by the Duquesne, Bonzano and 100% patent joints, but as these joints have only been in service a short time, no definite conclusions have been drawn. In several of our longer tunnels we are using Weber joints, which are giving us much better results than are obtained from the present angle bar.

While I feel certain the reinforced bar is far preferable to the old style angle bar, no figures have, as yet, been worked up as to the cost of maintenance, and I am unable to express any opinion as to what we can afford to pay for the new type of joint.

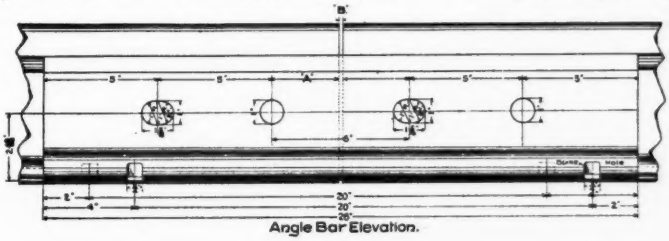


Duquesne Reinforced Rail Joint, 90-lb., A. R. A. Section "B"

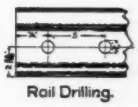
Attached you will find drawing of plain and reinforced joints that we are using in connection with ARA Sections "A" and "B" Rail that we purchased for our 1909 rail allotment.

You will note we are using plain wide nut locks of the Verona and National Types. We are at present time conducting several tests on patent nut lock devices, but same have not been in service long enough to draw definite conclusions as to their merits.

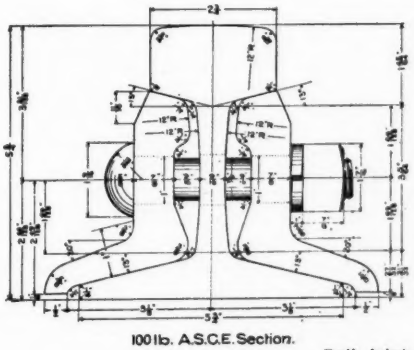
Rearding specifications for splice bars. At the present time we are purchasing our joints in accordance with Carnegie and



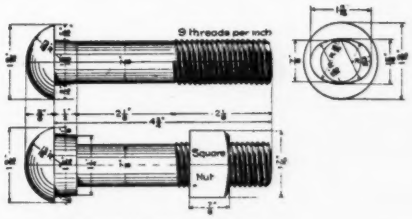
Angle Bar Elevation.



Rail Drilling.



100 lb. A.S.C.E. Section.

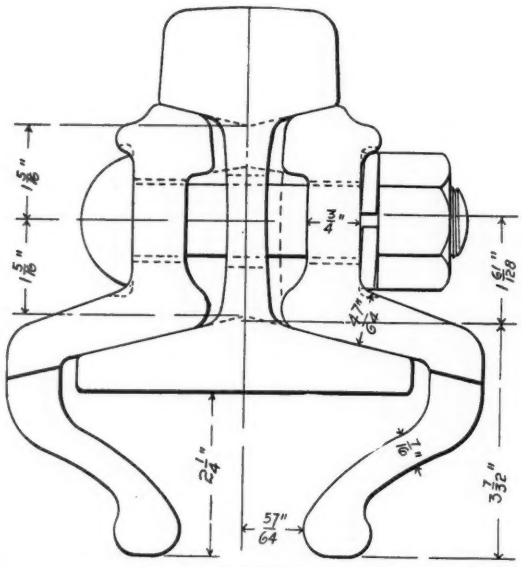


Standard Harvey Grip Bolt
For use with 100 lb A.S.C.E. Rail Joint.

Note.—Slots for Spikes shall be ⅝" wide and just deep enough to bring the spike against the base of rail.
Letter 'A' Distance 2 15/16" for 60 ft rail and 2 31/32" for 33 ft rail and shorter
Letter 'B' Opening ⅝ in for 60 ft rail and ⅜ in for 33 ft rail and shorter
Letter 'C' Opening 1⅜ in for 60 ft rail and 1⅛ in for 33 ft rail and shorter

Rail Joint Baltimore and Ohio Railroad.

Cambria Steel Companies' specifications. We have just completed our own specifications for Open Hearth Steel Splice Bars, and at a very recent date same were forwarded to the officials of our road for approval and have not been returned. After their adoption would be very glad to favor you with a copy of same.



90-lb., A. R. A. Section "B," Duquesne Reinforced Rail Joint

I regret very much that I am unable to give a more definite reply to your inquiry, but I feel we are in a transition stage and opinion formed from the present data compiled, are very liable to be at variance with what we may, at a later date, consider good practice.

Yours truly,

CHIEF ENGINEER M. OF W.

Spiking

Editor, Railway Engineering:—

I am afraid I have been somewhat dilatory in answering your letter, but as you are doubtless well aware, at this particular season of the year, when we are making preparations for the winter, the duties pertaining to track work are very heavy, and, consequently, the time for answering outside correspondence is very limited.

In answer to question No. 1, "Method of using track gauge." It is, and has always been, my practice to invariably use the track gauge whenever a new tie, or ties, is put in, and outside of this I make a semi-annual inspection and at these times I have the track gauge used on each and every section on my division, under my supervision.

Question No. 2: "Driving and pulling spikes." In pulling spikes it is our practice, whenever possible, to start the spike a little with a claw bar, and then put a fulcrum under the bar to prevent the spike from bending back; this has a tendency to leave the hole in good shape for plugging, which is always done whenever a spike is pulled.

In driving spikes we always drive them into the hole where the plug has been inserted, if it is possible to do so, this method we find prevents the ties being cut up by spiking.

The equipment used for gaging, plugging holes, etc., when respiking is very simple, consisting of track gage, spike maul and an adze.

For plugs I find that Juniper or hard pine give the best results both in lasting qualities and in holding the spikes in place.

We have experienced very little trouble with spread track on curves, as we use the "Goldie Claw Tie Plate" which to a very great extent obviates the spreading of track, and I am of the opinion that the Goldie Claw Tie Plate is the best friend to the track department that has ever been placed on the market.

Trusting that these few remarks will be of some service to you,

Very truly yours,

Maine. ROADMASTER.

Pile and Frame Trestle Bridges*

The chairman of the committee to whom was assigned the above named subject sent to the other members of the committee the following circular letter, which is printed here to show the method adopted in getting up this report:

"Please look over the list of questions which I submit herewith and make any suggestions which, in your opinion, will bring out a more complete report, or list to report upon. This is a broad subject and I may have omitted some important points. Also, what is your judgment in regard to submitting this list, when finally prepared, to all members of the Association? I believe this method has been generally adopted by committees heretofore in getting up reports; however, it entails a great deal of extra correspondence, and but few of the members seem to be willing or can find the time to respond to these requests from the various committees, as it requires a considerable amount of work, and if published in the report would be too lengthy to rehearse in full in the limited time usually accorded in the convention, and this being the case I think it would be better to confine this report to members of the committee only."

Replies from my associates approved of this method which was adopted, and the list of questions and answers follows:

LIST OF QUESTIONS.

1. What kinds of piling are used in bridges on your line, and what is your opinion of their value?

2. What, if anything, is being done in the way of preservation of timber and piling used in construction and renewals of trestle bridges on your road?

3. Give dimensions and furnish specifications pertaining to material used by your company in trestle bridges, and any opinion you have to offer concerning the utility of the material.

4. Have you a standard for ballast floor bridges on your road? If so, please state your reasons for approval or disapproval of this style of structure, added cost to be taken into consideration.

5. Which parts of timber trestles are most liable to failure, or require earliest renewals?

6. Give description of system of inspection of trestle bridges on your line.

7. What precautions, if any, are taken to guard against fires other than the provisions made in decks of ballast floor bridges?

In making your replies please furnish drawings, when possible, with proper references thereto.

ANSWERS TO QUESTIONS.

W. T. Powell, Colorado & Southern Ry., Denver, Col.:

1. For several years we used only long leaf yellow pine for piling, but they lasted only about six years, so we discontinued their use, and for the past two years we have been using oak, but they are so poor, account of being so small and crooked, that we are going to resort to the use of treated short leaf yellow pine. Good oak piles will last approximately sixteen years, and long leaf yellow pine about six, unless treated, which will lengthen their service.

2. This company has never used any treated bridge timbers.

3. Our main line bridges have 13-foot panels, three-ply 8x 16-26 stringers, 7x8-9 ties, 5x8-26 guard rails, and 14x14-14 caps,

*Report of Committee of the American Railway Bridge and Building Association.

all of Oregon fir. Timber specifications as follows: "Each and every stick must be sawed so that all edges are perfect; must be perfectly sound and clear from sap and clear of knots that will affect the strength of the timber, and entirely free of wind shakes and other imperfections. Must be as nearly the exact dimensions as possible." Specifications for piling: "All piles must be made from straight sound live timber, free from cracks, shakes and rotten knots, and must show an even taper from end to end; must be sawed square and bark removed. The pile must be not less than fourteen inches at the butt, and not less than ten inches at small end."

4. We do not use any ballast floor bridges.

5. Our main trouble is with the piling. The long leaf yellow pine rots out in about six years, while the decks of Oregon fir will last fifteen years. We sometimes have to change the ties sooner on account of being cut into by the rails.

6. We make a general inspection once each year commencing about September 1st. We dig around the piles to see how much they have rotted; also look for broken stringers and caps, as well as all of the other members. Some of the bridges are inspected several times each year; that is, our foreman, general foreman and myself look over carefully any bridges we may be near.

7. We have no fire protection for bridges, except for a few which are provided with water barrels.

J. F. Parker, Santa Fe Coast Lines, San Bernardino, Cal.:

1. We use mainly Oregon pine for piles. Have used some white cedar, also long leaf and short leaf yellow pine. The white cedar has given the best service, lasting from eight to fifteen years, depending upon soil and other conditions. Second cuts do not last so long. Oregon pine has given nearly the same length of service under like conditions; Oregon pine, however, in recent years, both for timber and piling, has been very inferior in quality as compared with that of ten or fifteen years ago. My experience with Texas pine dates back only about three years, consequently I am unable to give any information as to its probable value.

2. Creosoted timber and piling are being mainly used for construction, renewals and repairs of trestle bridges except for stringers and ties.

3. Caps, 12x14-14.

Stringers, 4 ply 7x16-28.

Ties, 6x8-14.

Guard rails, 6x8-14.

Sway braces, 3x10.

Cap struts, 6x10.

Longitudinal girts, 6x10.

4. We have a standard for ballast deck bridges, cuts of which appear on pages 165, 166 and 167 of the proceedings of the sixteenth annual convention. It consists of six piles per bent, 14-foot centers; 14x14-16 caps; solid close laid floor of creosoted timber 8x14 under the ties, and 10x10 from the ends of the ties each side to make up the full width of the bridge. I approve of this style of construction and consider it a good bridge in every particular. Thoroughly screened hard rock ballast should be used, for if fine gravel and stone dust collects at the bottom of the ballast it will hold the moisture and in time will rot the timber.

5. In our soil, piles are first to fail and require earliest renewals, except in salt or alkali ground, where they will last twenty years or more.

6. We make one general inspection annually, in May or June, when the condition of all parts of trestles is carefully noted, and records made thereof. When the notes are written up copies are sent to the general superintendent and chief engineer. We also have a regular bridge inspector who is constantly going over the line, looking after the welfare of bridges, drain boxes, buildings, mail cranes, etc.

7. Our largest trestles are now provided with metal water barrels which are kept filled by freight engines. The ground under and about trestles is kept free from dry weeds, grasses and other combustible material.

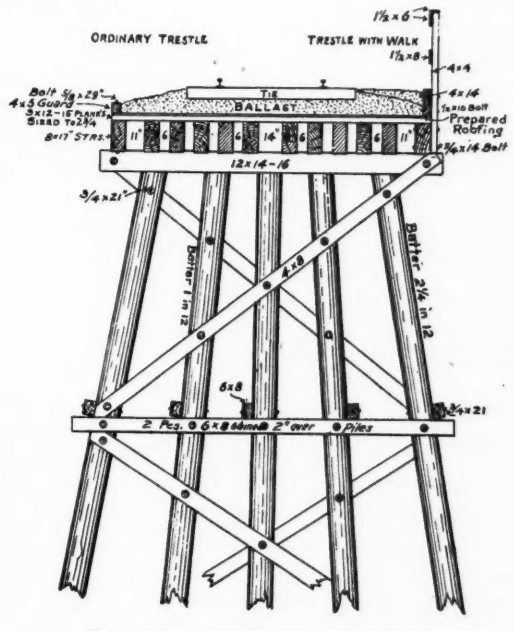
L. D. Smith, Southern Pacific Co., San Francisco, Cal.:

1. For piling we use Oregon pine and Washington fir, creosoted, except for temporary work. We believe this is the best material for the purpose on the coast.

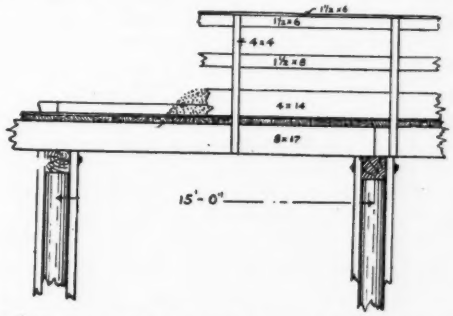
2. All piles are creosoted at the company's plant, using ten pounds of creosote per cubic foot. We do not creosote any other material in trestle bridges.

3. We use 12x14 caps, 8x17 stringers and 6x8 ties. (Pacific Coast Specifications, Harriman Lines.)

4. We use ballast floor trestle bridges wherever we have suffi-



THE CENTER LINE OF PILES PROLONGED SHOULD MEET AT A POINT ABOUT 26FT ABOVE BASE OF RAIL.



For trestles more than one story in height longitudinal girts to occur at vertical intervals of 12 ft, measured from top of cap, and at every 6th. bent towers to be framed.

For heights less than 16 ft. from ground surface to top of cap longitudinal caps to be omitted.

For heights less than 7 ft. from ground surface to top of cap sway bracing to be omitted.

Piles and caps to be creosoted. All other material untreated pine.

Prepared roofing to be laid with 3 in. lap joints, preferably lengthwise of trestle, and turned down 5 in. over ends of planking. Joints to have a coat of hot asphalt applied between laps and nailed with 4 d. nails, 2½ inches apart lengthwise of sheet and ¾" from edge.

Roofing to be reinforced with extra asphalt coat (½ lb. per sq. ft.) to make ⅛ inch thick and before laying temporary blocking or stringers on floor to carry traffic previous to ballasting spread a one inch coat of coarse sand or pea gravel to prevent blocking sticking to, or injuring the asphalt coating.

Coarse ballast (no dimension less than one inch) to be used next to guard timbers.

Floor planking will be spiked with 6 inch spikes, two at each end, and one at each intermediate stringer. On curves bents to be placed radial to center line of track and so spaced that outside stringers will be 30 ft. long. Superelevation to be effected by increasing depth of ballast under outer rail, the depth under inner rail remaining constant. Outside stringers to be driftbolted to caps at every bent. Inside strs. driftbolted at ends only except on openings 30 ft long when driftbolt at all bents.

Single Track Ballasted Deck Trestle, Oregon Short Line R. R.

cient head room. The cost is about 20 per cent greater than for open deck, but they are easier to keep in line and surface, and the stringers will last almost twice as long as in open trestle. The decks are fireproof; trains pass over them with less noise and jar, and the ties at the ends of the bridges on the embankments do not pound down as at the ends of open deck bridges. Such bridges require little or no repairs for fifteen to twenty years.

5. In open trestles we find that the tie gives out first under the tie plates, by crushing and rotting, where plates are used. In untreated trestles the piles give out first, thus requiring the renewal of the entire structure, or a very heavy expense for the redriving of piles. It seldom pays to drive a pile bridge and maintain the old deck.

6. Trestles are inspected quarterly by the superintendent of bridges and buildings, or his representative, and annually by the general bridge inspector. The piles are examined to a depth of eighteen inches below ground line. A common method is to sound the pile with a hammer, and those which seem to be decaying inside are bored. The same rigid examination is also made of the decks, and an estimate prepared of all that is required to keep the trestle in good repair for a year.

7. The only provision we have made so far on open decks is to paint the ties and tops of stringers and caps with fireproof paint. Water barrels are also provided and kept filled with water.

I am indebted to Mr. G. W. Rear, general bridge inspector, for the subject matter of these answers, for, since leaving the Gulf, Colorado & Santa Fe Ry. I have not had anything to do with bridge work.

B. J. Mustain, El Paso & Northwestern R. R., El Paso, Tex.:

1. We use Texas pine in all our pile bridge work. All piles are creosoted, which seems to be the most satisfactory treatment for use in this hot and dry climate.

2. All bridge timbers are creosoted, and built of 3x12 solid flooring on top of ten 8x16 stringers, as shown on pages 192 and 193 of sixteenth annual proceedings, which makes the bridge a very substantial structure. Caps 14x14-14. We use regulation size track ties with eight inches of gravel ballast between the planking and the ties. This makes the bridge fireproof from above, as any one tie will burn without destroying the bridge. This style of bridge is the best I have seen, and while more expensive to repair, it is more than offset by the greater length of life of the timber.

3. Where frame bents are used they are built on concrete foundations. Five 12x12 posts are used on sills of the same size. Sway braces, 3x10, are bolted to the sills, posts and caps. On double or triple deck bents, 8x12 line girts are used, and on heavy grades a diagonal brace reaches from the cap of one bent to the sill of next bent, which takes the place of tower bracing. I think, however, there is no method of bracing that is quite so safe as tower bracing. The El Paso & Southwestern is the only road where I have seen this style of diagonal bracing in use.

4. These bridges are all ballast decked.

5. Piling and posts at the ground line are first to decay, and consequently the first to receive attention.

6. Inspection is made twice per year, by digging around piles and sills, and testing them with bar or auger; estimate is then made of the amount of material that will be necessary for repairs or renewals. We make the inspection on a light train.

7. Where bridges are not ballasted, a 2x6 is placed between the ties and then covered over with gravel, which makes a good fire protection.

A. H. King, Oregon Short Line R. R.:

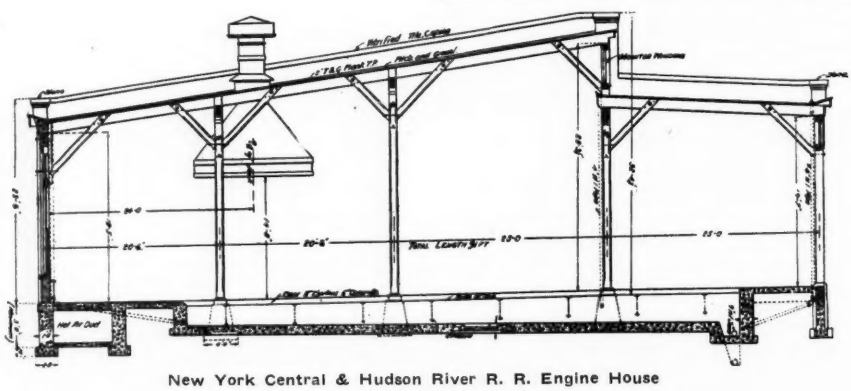
1. Oregon fir is universally used throughout this section for bridge work, either untreated, creosoted or salt treated. The latter method consists of placing the timbers in the waters of the Great Salt Lake, and should be kept submerged a year or longer. As long as the saline coating remains on the timber the crust proves a very valuable preservative, and piles driven 25 to 30 years ago in the lake are in perfect condition, but we are yet unable to say what the results may be when thus treated and used in other places, remote from the lake. Creosoting will prolong the life of piling, but the practice is so recent with us that we are unable to say how much longer.

2. Answered in No. 1.

3. Our common standard pile bridge consists of five piles in each bent. Three stringers 8x17-30 centered under each rail; 6x8-9 fir ties; 5x8 guard rail, and 12x14-12 fir caps. Piling is driven on a batter in such a way that if center line of each pile were extended they would meet 28 feet above the rail. Our company is of late favoring the ballast floor bridge for main lines. For this type we use a 16-foot cap and 12 stringers and 4-inch floor covered with prepared roofing over which is spread a coat of asphaltum about one-half inch in thickness (see plan). The prepared roofing and asphalt are used with the intention of making a watertight floor to keep the moisture from getting into the stringers. We have had instances where this style of covering for some reason was not a success; however, we believe this was due to the result of careless workmanship. A bridge stringer is bolted to the outside to retain the broken stone or gravel ballast, and common track ties are used. With treated piling and this style of deck we expect to add to the life of the structure, get better fire protection, and show less cost for maintenance, as the matter of line and surface is taken care of by the section men. We estimate that the various members of this style of structure will last about the same length of time, and that the added life of the structure will amply repay for the additional expense incurred in its construction.

4. Answered in No. 3.

5. In this inter-mountain country, where the rains are frequent, the deck of a bridge lasts longer than the piles. Piles which do not reach the water are the first to fail, but by treating them, and driving five or six to the bent, instead of four, as was formerly the custom, we expect to remedy this to a considerable extent. Experience has taught us that while oak piles will last longer than fir under average conditions, when



New York Central & Hudson River R. R. Engine House

not treated. By using treated piling we expect to prolong the life of them so that they will last as long as the superstructure.

6. Usually we start our bridge inspection about the first of September by making use of an engine, superintendent's car and caboose, the party being composed of the division superintendent, division engineer, supervisor of bridges and buildings and the roadmaster. For us, this system is the most satisfactory, and we get the best results. We make a very thorough and rigid inspection in every particular, examining faulty piles and timbers with a five-eighths steel bar. It is intended that the material in a bridge shall remain as long as it is safe, but the inspections are made in such a way that necessary repairs shall not be overlooked.

7. On open floor bridges, on branch lines, we plank between the ties, and block the openings at the ends of the ties, under the guard rails, and fill in with ballast, and we find a notable decrease in the number of fires in trestles. Bruised or partially rotted ties, bulk-heads and caps where sparks are liable to find a lodging place are an element of danger, and a double reason presents itself for the removal of such. Water barrels on high timber trestles should be watched closely, aand kept full of water. The ground beneath trestles should be kept free from weeds, grasses and other combustible material, which I think is a general rule on most roads.

Railway Engine House Construction*

The construction of engine houses has had a steady and gradual development, entirely in conformity and keeping with the development and increasing size of the locomotive. Most of the larger railroads are now building from 85 to 90 feet or more in depth, which also requires a corresponding increase in the length of turn tables, pits, etc.

Concrete is almost universally used for foundations, some roads carrying the concrete work to the height of the window sills, while a few have ventured to make use of reinforced concrete for the entire body of the structure. Some members have indicated a preference for brick walls on account of being easier to repair in case of having been damaged by an engine. It is difficult to foretell the result of an engine going through the rear wall of a reinforced concrete engine house, or tearing out a post, yet such is liable to be the case at any time.

A greater amount of attention has been accorded engine-house construction during the past few years, with reference to heating, lighting and ventilation. The most difficult problem, and one which figures largely in the matter of maintenance repairs, is that of smoke jacks. It is quite apparent that the large-mouthed jack has come to stay, and is rapidly taking the place of the small drop jacks which are commonly made of cast iron or tile. This style of jack is built up of wood or composition board, the composition material being manufactured of cement, asbestos and like ingredients. This design not only carries off the smoke and gases to better advantage, but permits of a wider range in the spotting of engines. Experience has taught that as little iron as possible should be left exposed in the construction of engine houses on account of the rapid deterioration due as a result of burning coal and coke.

The matter of roof covering is very important, and in recent years the manufacturer is making an effort to produce a composition covering of light structure, which is put on the market in rolls and requires simply putting in place and fastening, pretending to replace the old style tar and gravel roofs. These preparations can be used to good advantage on roofs which have a considerable slope where tar and gravel are not practical, but it will require time and experience to decide which is the cheapest and most durable for flat roofs.

Where a flat roof is used the monitor style of construction as shown on pages 135 and 137 of the Fourteenth Proceedings affords an excellent means of lighting, besides additional ventilation.

Modern engine houses are also being better equipped with heating, sewerage, water and washout systems, etc., in recent years.

REFERENCES.

We make reference to the following articles in technical magazines and in our own Proceedings, which contain much information in regard to details of engine house construction:

1. Roundhouse—Intercolonial Ry. of Canada, *Railway Review*, March 12, 1904.
2. Union Pacific Ry. Shops, *Engineering News*, May 9, 1891.
3. Comparison of Circular and Rectangular Engine Houses, *Engineering News*, March 3, 1904.
4. Brick Floors, Eighth Proceedings B. & B. Assn., page 102.
5. Smoke Jacks and Ventilation, Eighth Proceedings B. & B. Assn., page 112.
6. Turntable Construction, Eighth Proceedings, page 184.
7. Concrete Engine House Construction, Fifteenth Proceedings, pages 98 to 107.
8. Best Forms of Construction for Engine Houses, Fourteenth Proceedings, pages 128 to 189.

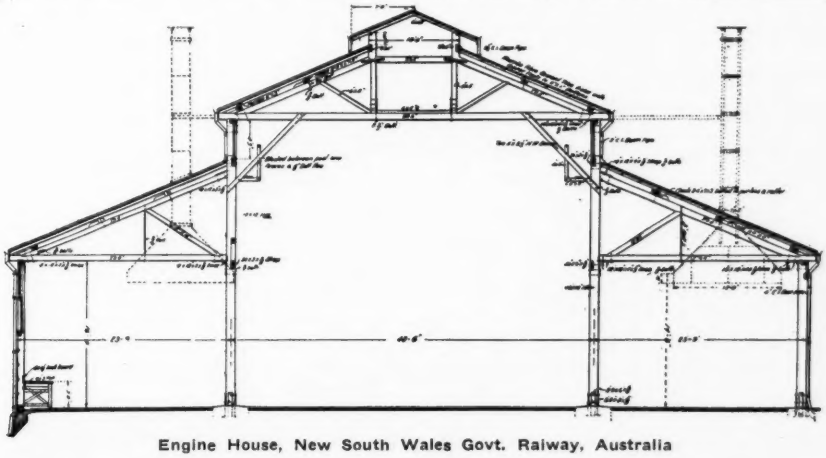
The committee sent out a number of letters of inquiry on this subject, and we think best to embody extracts from the same in the report. A few drawings of modern designs are also submitted.

EXTRACTS FROM LETTERS OF INQUIRY.

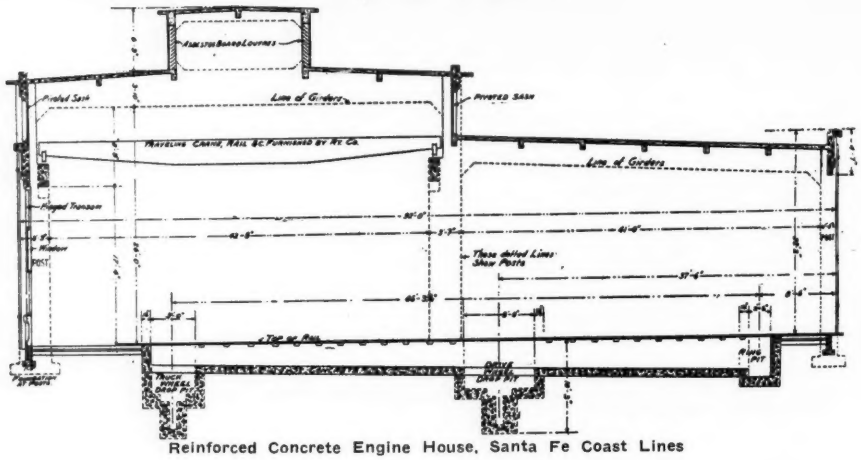
J. F. Parker, Atchison, Topeka & Santa Fe Ry.:

The A., T. & S. F. Ry. recently constructed a concrete engine house at San Bernardino, Cal., which is standard design for our coast lines. The cost of this house with pipe lines and sewers, and everything pertaining thereto, was $158,000. The house consists of thirty-five stalls, including traveling cranes, drainage, piping, concrete floor and pits. Rails on pits are fastened with rail clips. This is a complete building in every detail.

*Report of Committee No. 13 of American Railway Bridge and Building Association.



Engine House, New South Wales Govt. Railway, Australia



A. O. Cunningham, Wabash R. R.:

Forty-two stall frame engine house recently constructed by the Wabash Railroad at Decatur, Ill., cost $84,500, as follows:

Engineering	$ 1,000.00
Grading	600.00
Building (contract)	58,100.00
Roof	2,000.00
Steam Heat, piping and vacuum pump	6,220.00
Smoke Jacks	2,100.00
Electric wiring and lights	1,000.00
Telepher hoist inside house	1,000.00
Washout system	6,900.00
Drainage and sewerage system	1,950.00
Rail and track fastenings inside of house	1,675.00
Tracks between house and turntable	1,955.00
	$84,500.00

S. C. Tanner, Baltimore & Ohio R. R.:

At Riverside, Baltimore, the B. & O. R. R. recently built two engine houses of frame and reinforced concrete, twenty-five stalls each, with concrete drop and engine pits complete. The engines enter the house head on, which locates the machinery part of the engine at the widest floor space and at the highest point of elevation, to admit light and ventilation for machinists in making repairs. The floor is of vitrified brick laid on edge. The smoke jacks are built of cast iron with a hood on the inside of the house eight feet long and thirty inches wide. The entire building is heated with steam and supplied with water and necessary drainage. The roof is covered with four-ply composition roofing on 1⅜-in. tongued and grooved sheathing. Rolling doors of wooden slats are used instead of framed doors on hinges.

R. H. Reid, Lake Shore & Michigan Southern Ry.:

Forty-stall engine house at Ashtabula, Ohio, now being constructed by the L. S. & M. S. Ry., is frame with concrete foundations. Estimated cost is $3,300 per stall. Smoke jacks, made of wood and plastered with asbestos, will cost $175 each.

John Ewart, Boston & Maine R. R.:

Our standard brick engine house is 75 feet deep and costs complete about $1,600 per stall. The heating, four 1¼-in. pipes, two sides and one end (which is included), costs from $90 to $100 per pit, and the drain (also included), about $45 per pit. Roof, five-ply tar paper and gravel. Have used the Dickinson and also wooden smoke jacks, and a few made from asbestos board. Floors are paved with brick laid on edge and grouted. Timber cap on pits for rails. We are working on plans for an 85-ft. house which will be different from anything that we now have.

James Fraser, New South Wales Government Railways:

Twenty-stall circular engine house, including ash pits and brick floors, estimated at $45,000.

Government Transfers Works of Forest Products Investigation

Preparations have been completed for the transfer of all the government's forest products work to Madison, Wis., where the U. S. Forest Service Products Laboratory will be located, and to Chicago where the headquarters of the office of Wood Utilization will be established.

The new Forest Products Laboratory being erected at Madison by the University of Wisconsin, which will co-operate with the Government in its forest products work and which is to cost approximately $50,000, is now in the course of construction. The laboratory will be a fire-proof building of brick trimmed in white stone and is located near the Chicago, Milwaukee & St. Paul Railroad with exclusive tracks and other railroad facilities. The building is expected to be ready for occupancy upon January 1. In the meanwhile temporary offices will be located at 1610 Adams street, Madison.

On October 1 the Yale Timber Testing Laboratory was discontinued and the Forest Service equipment there shipped to Madison. The Laboratory here at Washington was discontinued at the same time. The Timber Testing Laboratory at Purdue, Indiana, will be operated until the middle of December when it will be discontinued and its equipment shipped to Madison.

The offices having general supervision over all the work of the branch of products will remain temporarily at Washington. W. L. Hall, Assistant Forester, continues in charge of Branch of Products and McGarvey Cline will be Director of the Madison Laboratory. The work of the Laboratory will be assigned to five offices, as follows:

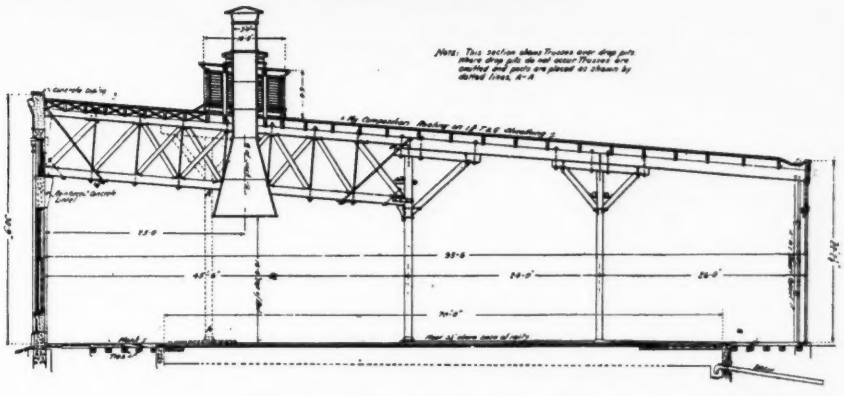
Wood Preservation, which will study all problems related to the impregnation of wood with preservatives and other substances.

Wood Chemistry, which will handle all work bearing on the chemical utilization of forest products. Wood Distillation, paper pulp and other fiber products, chemical analyses of creosotes, turpentines, etc., are the principal lines handled by this office.

Timber Tests, which will have charge of all tests to determine the strength and other mechanical properties of different woods.

Technology, which will study the microscopic structure of wood, methods of seasoning and drying it, and other problems of a purely technical character.

Maintenance, which will have charge of the filing and computing. It will also be responsible for the purchase of supplies and general care of the entire Laboratory.



Baltimore and Ohio R. R. Engine House

The class of work in the Laboratory may be separated into three kinds, as follows:

1. The investigation of problems in experimental research.
2. Experimental work in co-operation with commercial plants to verify Laboratory experiments on a commercial scale.
3. Co-operation with outside parties for the purpose of assisting them in applying principles and processes of recognized commercial value with which the Service is thoroughly familiar.

The supervisory staff of the Laboratory is as follows:

McGarvey Cline, Director.
H. S. Bristol, in charge of Wood Chemistry.
H. D. Tiemann, in charge of Technology.
H. F. Weiss, in charge of Wood Preservation.
Rolf Thelen, in charge Timber Tests.
W. H. Kempfer, in charge of Maintenance.

The technical force will in part be made up of the following men:

H. E. Surface, Engineer in Wood Chemistry.
Edwin Sutermeister, Wood Pulp Investigations.
Jason L. Merrill, Chemist.
E. Bateman, Chemist.
L. F. Hawley, Wood Distillation Investigations.
Frederick Dunlap, Kiln Drying Investigations.
C. D. Mell, Microscopist.
W. D. Brush, Microscopist.
C. J. Humphrey, Pathologist, detailed from the Bureau of Plant Industry.
F. W. Bond, Mechanical Engineer.
E. W. Ford, Mechanical Engineer.
C. T. Barnum, Mechanical Engineer.
C. P. Winslow, Civil Engineer.

The work of the office of wood utilization at Chicago will consist of studies of the wood-using industries of various states, the study of woods in manufacture and of the methods of disposing of mill waste, the collection of statistics on the price of lumber at the mill and at the principal distributing markets of the country, and the study of specifications and grading rules. The office will also secure statistics of forest products of importance to the experimental work of the Service and the study of the movements of lumber and of the conditions of the principal lumber markets.

The personnel of the office of wood utilization for the present is as follows:

H. S. Sackett, in charge.
Hu Maxwell.
Franklin H. Smith.
Roger E. Simmons.
Charles F. Hatch.

The Signaling Department

Canadian Pacific Signal Rules

SWITCH AND SIGNAL LAMPS.

Signal lamps and their attendants are in charge of the Bridge and Building Masters.

(a) Switch lamps and their attendants are in charge of Roadmasters.

(b) All lamps in service must be kept in first class condition. Defective or leaky lamps shall be sent to the storekeeper for repairs, and, defective workmanship or material in lamps shall be reported on defective material reports by the Bridge and Building Master or Roadmaster.

(c) All lamps must stand firm and plumb in their sockets.

(d) All lenses shall have corrugations on the inside. Lamps having chipped red lenses must be replaced at once.

(e) Semaphore spectacle glasses shall be inspected and cleaned, if necesssary, each time lamps are removed for filling and cleaning. Broken spectacles or lenses which give the wrong color must be reported by wire to the despatcher unless they can be remedied at once.

2.—In cleaning lamps remove all dirt from burners and lenses, particularly that in the corrugations; remove all soot from top or bottom of lamp, clean all holes for ventilation or air supply, and remove all crust with the fingers from the top of the wick.

(a) Empty and clean with fresh oil, if necessary, all lamp fonts once a month in summer and twice a month in winter. Dirty oil must not be used in lamps.

(b) Standard kerosene oil, as supplied by the company, shall be used for all switch and signal lamps. Signal oil is to be used in lanterns only.

3.—Lamps must not be filled more than to one-half inch below the top of the font. All wicks must be long enough to reach the bottom of the font, and they must fit burners snugly, but work freely.

(a) All lamps except long-time burners must be cleaned and filled daily. Wicks must be turned down below the top of the wick tube when not burning.

4.—Long-time burner lamps require cleaning, filling and relighting twice a week. They will usually be attended by the section men on Saturdays and Wednesdays.

(a) Wicks in long-time burners must be changed once every 60 days or oftener if they become dirty, hard, or if a large amount of crust accumulates.

(b) Long-time burners may be used in all switch or signal lamps.

(c) New wicks in long-time burners are to be trimmed evenly with scissors or a sharp knife.

5.—After lighting any switch or signal lamp and putting it in the body and closing the door, it should be looked at in five

or ten minutes to see that it does not smoke, at which time the flame should be about ¾ in. above the top of the burner, and at the same height as the centre of the lens.

INTERLOCKING DEFINITIONS.

Interlocking.—An arrangement of switch, lock, and signal appliances, so interconnected that their movements must succeed each other in a pre-determined order.

Interlocking Plant.—An assemblage of switch, lock and signal appliances, interlocked.

Interlocking Station.—A place from which an interlocking plant is operated.

Interlocking Signals.—The fixed signals of an interlocking plant.

Home Signal.—A fixed signal at the point at which trains are required to stop when the route is not clear.

Distant Signal.—A fixed signal used in connection with a home signal, to regulate the approach thereto.

Dwarf Signal.—A low fixed signal.

Signal Mast.—The upright to which the signals are directly attached.

GENERAL PRINCIPLES.

1.—(a) The style of signal used in the semaphore.

(b) The arm of a home signal has a square end, the front is painted red with a white band, the back is painted white with a black band. It is placed on a signal mast at least twenty feet above the track.

(c) The arm of a dwarf signal has a square end, the front is painted red with a white band, the back is painted white with a black band. It is placed on a signal mast about three feet above the track.

(d) The arm of a distant signal has a forked end, the front is painted yellow with a black "V" shaped band, the back is painted white with a black "V" shaped band across the blade. It is placed on a signal mast at least twenty feet above the track.

(e) The governing arms shall be displayed to the right of the signal mast, as seen from an approaching train.

(f) The back view of an interlocking signal does not govern the movements of trains.

(g) The indications are given by not more than two positions of an arm; and, in addition, at night by lights of the prescribed color.

(h) The normal indication of a home signal or a dwarf signal is "STOP," and of a distant signal is "CAUTION."

(j) The apparatus is so constructed that the failure of any part directly controlling a signal will cause it to give the normal indication.

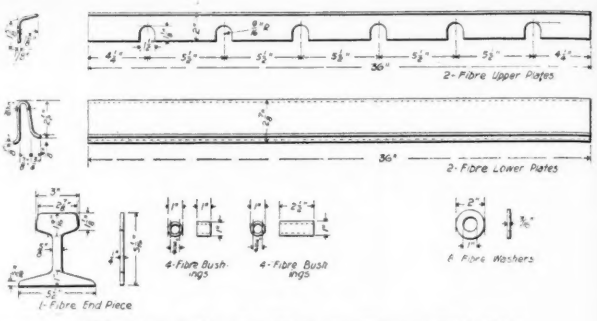
(k) The apparatus is so constructed that the failure of any part directly controlling a switch or lock will prevent the display of a clear signal.

(l) The signals, if practicable, are either over upon the right or the outside of and adjoining the track which they govern.

(m) When main running tracks are so situated that sufficient space cannot be obtained to admit of the signal masts being located adjoining the track which they govern, the masts may be located either on a signal bridge directly over the centre of the track they govern or on a bracket post.

(n) When parallel tracks are to be governed the masts carrying the signals governing them should stand in the same relative positions as the tracks governed. On bracket posts, signals on the right hand must refer to the main running track farthest to the right, the signals on the next mast to the left refer to the main running track to left of the first mentioned track, and so on for each main running track operated in the same established direction.

(o) The indication governing a main running track movement in the established direction will be given by a Home Signal.



Fiber Insulation for 95-lb. Continuous Rail Joint

(p) The indication for a main running track diverging movement in the established direction at a junction will be given by one or two Home Signals located one above the other on the same mast, the topmost signal will govern the superior route and the lower signal that of the secondary or inferior route.

(q) The indication for a diverging movement from the main track in the established direction to a secondary or side track will be given by a Dwarf Signal located to the right of and adjoining the track to which it refers and either at the foot of or opposite the Home Signal. The light on the Dwarf Signal corresponding to the Stop indication will be shielded off, the Home Signal alone giving the Stop indication and the Dwarf Signal the clear indication for the diverging movement.

(r) The indication for a reverse movement from the established direction on or from a main running track, or for a movement in either direction on a side track, or from a side track to the main running track, will be given by a Dwarf Signal.

(s) Distant Signals will give advance information in regard to one Home Signal only. When there is more than one signal on the Home Signal mast the Distant Signal will work in connection with the topmost signal.

RULES GOVERNING THE USE OF NON-INTERLOCKED SEMAPHORE SIGNALS.

1.—The type of yard limit signal shall be C. P. R. standard semaphore.

2.—Two light back spectacle semaphore shall be used as follows:

(a) At all divisional points.

(b) At all stations where regular switching engines are engaged.

(c) All stations where the first switch cannot be seen from an approaching train for a distance greater than 1,000 ft.

(d) The use of distant semaphore is restricted to such points as are approved by the General Superintendent and Engineer Maintenance of Way.

3.—Standard semaphore with one black light casting will be used as follows:

(a) At junctions, railway crossings and drawbridges not protected by interlocked plants.

4.—In the erection of semaphores observe the following:

(a) Semaphores shall be placed on the engineer's side of an approaching train 8 feet from the nearest rail and as far out as the General Superintendent approves.

(b) The arm to extend to the right as seen from an approaching train. For double track operating to the left, semaphores shall be placed on the left side and the arm shall extend to the left, as seen from an approaching train.

(c) Posts supporting wires shall be of an even height of 4 ft. above base of rail, parallel thereto, 40 ft. apart, and not less than 8 feet from nearest rail.

(d) Railway, highway or farm crossings not more than 20 ft. in width shall be crossed by underground wires passing

through 4-inch cast iron pipe or a wooden box with an opening of 3½ in. square placed as near the surface of the ground as practicable.

(e) Where wires cross highways more than 20 ft. in width or a number of tracks, such as in yards, they must run in ½-inch galvanized iron pipe provided with a stuffing box at each end, pipe to be filled with black oil.

Insulated Rail Joints

Editor, Railway Engineering:—

We are using at the present time on our road, the continuous type rail joint and the old style fibre joint. The continuous type we purchase from the Rail Joint Company, using Whall fibre. The continuous type joints are placed in the main tracks only, while the old style joints, that is, the fibre plates with the planed angle bars, are used only on side tracks and crossovers.

From past experience we find the continuous type joint will last approximately eight months, depending greatly of course on the location as to grades, etc. The old style fibre joint on sidings, etc., will hold out perhaps for eighteen months. However, we do find that the joints will hold up much better on our heavier rail, that is, better on our 95 lb. rail than on our 75 and 76-lb. rail.

The drawing shows the thickness of the fibres, etc., and also show the divided fibre plates which we use. By using the divided fibre plates, the top plate at the head of the rail can be changed while the bottom one may be left on and will probably last as long as three of the top plates.

Hoping that the foregoing information will be of assistance to you on the subject of insulated joints, I am

Yours very truly,

SIGNAL ENGINEER.

Automatic Stops and Cab Signals

During the past year there have been a large number of Automatic Stop and Cab Signal Systems brought to the attention of the Committee, and while many of them fail to comply with the requisites of installation, there are a number of inventors working seriously to produce apparatus that will meet these requirements.

The Committee has investigated all of the systems that have been brought to its attention and individual members have visited a number of experimental installations in various parts of the country, but owing to the fact that these installations have been made at the request of the Block Signal and Train Control Board of the Interstate Commerce Commission does not feel that it should comment upon them prior to the report of the official board.

The principal installations that have been made for test and observation by the Board are as follows:

The Rowell-Potter System, installed upon the C. B. & Q. Ry., near Aurora, Ill.

This is an arrangement of the mechanical trip type stop with external fixed signals. Cab signals may be used if desired. Power for the operation of the stop and signals being derived from powerful springs wound by the wheels of a passing train.

The Simmen System, installed upon the Toronto & York Radial Ry., in Canada.

This is an intermittent contact rail train signal system. The cab signal is given by the dispatcher and the train automatically records its progress over the road in the dispatcher's office.

The Perry Prentice System, installed upon the Chicago Suburban Ry., near Chicago.

This system makes use of Hertzian waves, to operate the relay controlling the stopping and signaling devices upon the train, there being at no time any physical or electrical connection between the track structures and the train.

In addition to the above installations that have been made, there are under consideration a few other devices of the intermittent contact rail type which appear to possess some merit, but it is not probable that the Board will conduct any tests of such devices until after one typical system of this type has been tested in actual service.

A number of devices employing insulated wheel or axle in connection with short insulated sections of one or both track rails have been submitted, and if a consideration of them justifies it, the Board will undoubtedly conduct a test upon systems of this type.

Train control devices are under consideration which depend for their operation upon inductive relations between electrical circuits on the train and electrical circuits on the track, no mechanical or electrical contacts being used. These include a device which is intended to depend for its operation upon the non-magnetic property of manganese steel rails.

A very simple form of overhead mechanical trip of the freely suspended or inertia type which has been in service upon a steam railroad for a considerable time is being considered and will probably be tested by the Board.

A very able description of the use of Cab Signals in England and on the Continent will be found in the First Annual Report of the Block Signal and Train Control Board.

Sub-Division A.

Pursuant to instructions of the Executive Committee, your Committee has carefully considered the report presented in 1908, giving due weight to all of the published criticisms of the report, and while it unanimously approves in general the conclusions of the previous committee, begs to submit the following additions and changes in the requisites.

Note.—The Committee in its deliberations has defined the word requisite to include not only the essentials that an acceptable Automatic Stop and Cab Signal System must possess but also the desirable characteristics it should have.

Requisites adopted in 1908.	New and changed requisites proposed for 1909.
1. Apparatus and circuits so constructed that a failure of any essential part will cause the display of a stop signal indication and also the working of the automatic stopping device.	1. No change.
The automatic stop device should be possible of arrangement so that it will not be operative or effective when the speed of the train is less than five miles per hour.	
2. The train control feature must be applicable for use with the absolute or the permissive operation.	2. The train control feature must be applicable for use with the absolute or the permissive block operation.
With either system the release of the stopping device must be within the control of the engineman or trainman, but only after the speed of the train has been reduced to five miles per hour or less.	With either system the restoration of the stopping device and the release of the brake must be within the control of the engineman or trainman but only after the speed of the train has been reduced to five miles per hour or less.
3. The automatic stopping device must be operative only in the direction of traffic, except in connection with signals governing reverse movements.	3. No change.

*Report, in part, of Committee No. 6 of the Railway Signal Association.

4. The system must be operative under all weather conditions.

4. No change.

5. The system where track circuits are used must be adaptable for use with a block system using track circuits.

5. No change.

6. The system must give protection against a broken rail, the ends of which have separated, or where a rail or section of a rail has been removed from the track.

6. The system where track circuits are used must give protection against a broken rail, the ends of which have separated or where a rail or section of a rail has been removed from the track.

7. The parts on the moving train must not extend beyond the maximum clearance lines and the parts on the ground must not extend within the maximum clearance lines except for a space of two (2) feet above the top of the rail, within which distance the parts must clear the maximum equipment line.

7. No change.

8. An overlap equal to the breaking distance for the maximum permissible speed must be provided for automatic stopping devices.

8. No change.

9. Emergency application of the brakes should be made only when a home or dwarf signal has been run by, when indicating stop. If the system is arranged to cause an application of the brakes when a train passes a distant signal that is indicating caution, the application of the brakes must not occur if the home signal is indicating proceed, or if the speed of the train is being controlled so that the train will be stopped before passing the home signal.

9. No change.

10. The circuits must be arranged to allow two or more engines to be used with one train, or to allow one train to push another train without having the automatic stop applied at each home signal or require the speed to be reduced to five miles per hour when passing a home signal that is indicating proceed.

10. The apparatus must be arranged to allow two or more engines to be used with one train or to allow one train to push another train without having the automatic stop applied to the second or following engine or to require the speed to be reduced to five miles per hour, when passing a home signal that indicated proceed when the head of the train passed the signal.

11. The automatic stop must be adaptable for use with electric traction systems, using direct or alternating current for train operation.

11. No change.

12. The Automatic Stop and Cab Signal should be considered only as adjuncts to a fixed signal system.

12. Eliminate No. 12 as this is more properly a conclusion than a requisite.

Note.—This is on account of the impossibility of properly checking the work of the engineman if a cab signal or automatic stop is used without a fixed signal and also from the necessity of informing the engineman of the exact commencement of the block and the point at which the indication received in the cab shall become effective.

Note.—Committee's recommendation on this subject will be found in the conclusions to this report.

12. (New) Apparatus so constructed that an audible alarm is sounded each time the brakes are applied by the stopping device.

13. The cab signal shall be given by visible signals of prescribed form, the indication given by not more than three positions and in addition a separate and distinct alarm shall be sounded for the Proceed with Caution and Stop Indications.

14. Apparatus so constructed that the obstructing train must not be required to have special apparatus to cause the application of the brake or the display of the Stop signal on the approaching train.

15. Apparatus so constructed that the visual indication of the cab signal is continuous.

16. Apparatus so constructed that the Proceed signal indication will change to Proceed with Caution in case signal has been passed in the Proceed position and it is desired to stop the train at the next signal.

17. Apparatus so constructed that the condition of the block occupied and the first block in advance is continuously indicated by the signal displayed.

18. Apparatus so constructed that the cab signal indication will be correctly displayed when the engine is moving either forward or backward with current of traffic.

19. Apparatus so constructed that the engineman can recover full control of his train in case of failure of the apparatus after coming to a stop. If the automatic stop is cut out due to a failure a visible record of such action must be provided.

Sub-Division B.

Requisites of installation for Automatic Stops and Cab Signals for Electric Lines running on the surface or otherwise and carrying passengers only.

1. Apparatus so constructed that the failure of any essential part will cause an immediate application of the brakes, the cab signal to display the Stop indication and the sounding of an audible alarm.

2. Apparatus so constructed that it is adaptable to external fixed signals, either block or interlocking, with or without track circuits.

3. Apparatus so constructed as to automatically enforce obedience to adverse signal indications.

4. Apparatus so constructed that it is unaffected by weather conditions.

5. Apparatus so constructed that a Caution indication of the cab signal will be displayed when any condition exists that endangers the train in the first block in advance and a Stop indication when in the block occupied.

6. Apparatus so constructed that the parts on the train do not extend beyond the maximum clearance lines and the parts not carried by the train must clear the maximum clearance line between the bottom of steps and eaves of cars and at all other places must clear the maximum equipment line.

7. Apparatus so constructed that the automatic stop will be applied at a point in rear of the point of danger at a distance equal to or greater than the breaking distance at the maximum permissible speed, if the speed exceeds five miles per hour.

8. Apparatus so constructed that the automatic stop may be released if applied at a distant signal if the home signal indicates Proceed or the train is being controlled so that it will stop before reaching the home signal.

9. Apparatus so constructed that the engineman can recover full control of his train in case of failure of the apparatus after coming to a stop. If the automatic stop is cut out, due to a failure, a visual record of such action must be provided.

10. The apparatus must be arranged to allow two or more engines to be used with one train or to allow one train to push another train without having the automatic stop applied to the second or following engine or to require the speed to be reduced to five miles per hour, when passing a home signal that indicated Proceed when the head of the train passed the signal.

11. Apparatus so constructed that it is adaptable for use with either direct or alternating current traction systems.

12. Apparatus so constructed that an audible alarm is sounded each time the brakes are applied by the stopping device.

13. Apparatus so constructed that after a train has stopped for a signal indicating Stop, the automatic stop will not be effective if the speed of the train passing the signal is less than five miles per hour.

14. Apparatus so constructed that an obstructing train must not be required to have special apparatus to cause the application of the brakes and the display of the Stop signal on the approaching train.

15. Apparatus so constructed that the Proceed signal indication will change to Proceed with Caution in case a signal has been passed in the Proceed position and it is desired to stop the train at the next signal.

16. The Cab Signal shall be given by visual signals of prescribed form, the indication given by not more than three positions and in addition a separate and distinct alarm shall be sounded for the Proceed with Caution and the Stop indication.

17. Apparatus so constructed that the condition of the block occupied and the first block in advance is continuously indicated by the signal displayed.

18. Apparatus so constructed that the cab signal indication will be correctly displayed when the engine is moving either forward or backward with current of traffic.

Sub-Division C.

Report as to the desirability of using automatic stops with cab signals or interior indications. No external system of fixed signals being used.

Automatic stops with cab or interior signals are not, to the knowledge of the Committee, in use without some form of exterior fixed signal.

No system has been tried out over any extended period that has been found sufficiently reliable for an engineman to depend upon, without the aid of the external fixed signals.

In England the Board of Trade has given permission to take down the fixed distant signals when certain forms of cab signals without automatic Stops are used. The cab signals have not, however, been sufficiently successful for the Board to authorize their use in lieu of home signals.

Climatic conditions in England are very much different from what they are in this country and only extended trial would show whether a successful apparatus under the climatic and operating conditions of England would be equally successful in this country for distant signal indications, even if automatic stops were in use to enforce obedience to the indications.

The apparent advantages of a cab signal system without external fixed signals, if constructed according to the requisites of installation given in this report, would be as follows:

(a) Signal indications would not be obscured by weather conditions.

(b) Signal indications would be simple as only the signal for the train governed would be displayed in the cab.

(c) Signal indications would be constantly displayed before the enginemen.

Some of the apparent disadvantages of a Cab Signal System, if used without fixed signals, would be:

(a) If the cab apparatus fails the train would have to proceed over the entire division without signal indication.

(b) In case of a wreck the evidence as to the signal indication would probably be destroyed and the responsibility for the wreck could not be placed.

(c) There would probably be confusion in operating, due to the difficulty of indicating the limits of the danger zone, and the point at which the signal indication applies.

(d) As signals are but one of the many things that an engineman must observe, it is necessary that a sharp look out be maintained at all times and a cab signal would cause a continual diversion of the engineman's attention from the outside to the inside of the cab.

While there may be developed systems which will prove reliable enough to be used, at the present writing, nothing has stood the test of practical operation necessary to warrant your Committee in recommending the use of automatic stops without external fixed signals.

Sub-Division D.

Report as to the desirability of using automatic stops with an external fixed signal system.

The use of automatic stops which will conform to the requisites of installation as given in this report and with external fixed signals will be in particular locations highly desirable, and there is no doubt in the mind of your Committee that they would be a valuable adjunct. When located correctly they would reduce the number of accidents which occur from unfavorable weather conditions and physical incapacity or negligence of enginemen.

The location at which the automatic stop can be used should be decided upon only after a thorough study of local conditions has been made giving due weight to the breaking distance of the train at maximum speed and to the frequency of train movement.

An indiscriminate installation of Automatic Stops would seriously decrease the operating capacity of the road or compel a very large increase in the cost of the signal installation without a commensurable return for the money invested.

The automatic stop must not be regarded as a device for habitually controlling the train, on the contrary each operation of the stop should require an explanation from the engineman why he was not properly controlling his train. Used in this way it has proven a valuable adjunct on certain electric lines of fast and dense passenger traffic where inspection has been ex-

ceedingly thorough and unfavorable weather conditions have been largely eliminated.

When the requisites of installation have been met for surface roads the automatic stop will be found successful when conditions of traffic make the use of it desirable.

Conclusions.

Your Committee recommends the adoption of the following conclusions:

First. That the requisites of installation set forth in this report outline the necessary qualifications for Automatic Stop and Cab Signal Systems.

Second. That in the present state of the art the Automatic Stop and Cab Signal should be used only as adjuncts to a fixed signal system and then only when the requisites of installation as set forth in this report are complied with.

Best Method of Housing Railway Bridge and Construction Gangs

The committee on subject No. 8, continued from last year, received from the former committee a vast amount of data, plans, etc., which had been collected, and it seems to us, after thorough investigation, considering the very thorough work which it did, that which is needed most at present, is not so much the further investigation and collecting of data, but more discussion and the relating of actual experience of the members of this Association.

A brief examination of the Eighteenth Annual Proceedings shows that the committee received plans and data from 41 of the leading railroads; these were very elaborate, and the committee selected those which best brought out the main faatures for publication in the proceedings; in view of all this the present committee did not feel that they should, in justice to all concerned, ask for additional information and data this year, but as the subject is a live one and worthy of careful study and consideration, we recommend that it receive a thorough discussion at the coming convention.

The present committee received from Mr. H. R. Higgins many plans of buildings for the housing of Panama Canal laborers, but they are more elaborate than would be required in railway service, and in fact a very few jobs would warrant such an outlay.

The subject seems to divide itself naturally under two heads: first, the housing of men engaged in ordinary maintenance work; for this, in nearly all cases, the boarding car outfit is far the better, having many points of advantages over portable buildings, especially in the ease with which they may be moved to different points as needed and the possibility of mobolizing a large force well housed, in cases of emergency, when fire, flood or wreck may have caused great damage and a large force is necessary for speedy repairs. A good sample of boarding car outfit was illustrated in the Eighteenth Proceedings. Second, the housing of men engaged in building new lines; this is where the portable or knock-down building has the advantage over the boarding car, as it may easily be carried ahead into the wilderness, and quickly erected, providing home and comfort for the pioneers, and as the work advances be moved ahead at a small cost with convenience.

We would be very glad indeed to be able to present plans of an ideal knock-down camp outfit, but have been unable to obtain one which, in our judgment is ideal; in fact, we do not consider that any of the plans submitted for either buildings or boarding cars are strictly ideal, but we do feel that the boarding car problem has been worked out to better satisfaction than the portable or knock-down house; there is no doubt but that many railroads would find it greatly to their benefit if they provided more comfortable and convenient quarters for their construction gangs, for men well housed and well fed will do far more and far better work than if compelled to put up with poor accommodations.

*Report of Committee No. 8 of the American Railway Bridge and Building Association.

Canal Half Excavated

The grand total of Canal excavation down to the end of September was 87,172,058 cubic yards, which was only 322,479 cubic yards short of one-half of the total excavation to be made for the completion of the canal. As the average daily excavation is over 100,000 cubic yards the output of the first week in October was ample to put the record safely past the half-way mark. The details of the excavation since the beginning of American occupation, by divisions and sections, were published in the Canal Record.

The grand total of canal excavation in September was 2,836,385 cubic yards, which is 81,207 cubic yards more than the total for August, and 1,043,952 cubic yards less than the highest record, that of March, 1909. Of the 2,836,385 cubic yards, 2,771,245 were charged to "work" excavation and 65,140 to "plant." The dry excavation amounted to 1,713,233 cubic yards, and was principally by steam shovels. The dredges removed 1,123,152 cubic yards, in addition to the amount pumped into Gatun Dam by the three suction dredges on that work.

In the construction of the locks, 13,733 cubic yards of concrete were laid; 3,741 cubic yards were laid in the spillway of Gatun Dam, and 4,023 cubic yards were laid in municipal work, a total of 21,497 cubic yards of concrete. The fill placed in dams amounted to 451,783 cubic yards.

There were 25 working days during the month, one less than in August. The mean rainfall in the territory in which excavation was in progress was 10.07 inches, as compared with 9.28 inches during August.

In the Atlantic division the work of constructing Gatun locks was continued, and 11,364 cubic yards of concrete were laid. In Gatun dam spillway, 3,741 cubic yards of concrete were laid, and the hydraulic and dry fill added to the dam amounted to 412,152 cubic yards. The total excavation was 540,114 cubic yards, 9,555 cubic yards more than in August. Of this total, 113,827 cubic yards were dry excavation, principally by steam shovels, and 426,287 cubic yards were removed by dredges.

The total excavation in the Central division was 1,471,796 cubic yards, practically all of which was by steam shovels. This was 66,883 cubic yards more than were removed in August. Of this total, 1,235,183 cubic yards were taken from Culebra cut, 65,841 cubic yards more than were excavated in the cut in August.

In the Pacific division the work of placing concrete in the locks at Pedro Miguel was begun on the first of the month with a temporary plant. During the month 2,369 cubic yards of concrete were laid. The total excavation in this division was 824,475 cubic yards, of which 696,865 cubic yards were removed by dredging, and the remainder was dry excavation. The fill added to the dams at Pedro Miguel and Miraflores amounted to 39,631 cubic yards.—The Canal Record.

The East Pittsburg shops of the Westinghouse Electric & Manufacturing Company are beginning work on a very heavy order for railroad motors for the Long Island Railroad, which represents almost a million dollars. This calls for 260 motors of 200 h. p. each, which will be used to equip part of the cars on the Long Island system, and is in line with the enormous development work the Pennsylvania Railroad Company is now doing in anticipation of the completion of the New York terminals and tunnels under the North and East rivers.

The straightening of old rail, for use in reinforcement of the concrete in the locks, which was begun by heating and hammering them out, has been discontinued. About fifty tons of rail will be straightened cold in the hydraulic forming press at Empire shops and sent to the Atlantic and Pacific divisions to be tested. The results of the tests will determine whether or not the remainder of the rails will be straightened by heating or by the cold process.—The Canal Record.

RAILWAY ENGINEERING
AND MAINTENANCE OF WAY.
BRIDGES-BUILDINGS-CONTRACTING-SIGNALING-TRACK

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Railroad Accidents

In this brief review mention is first made of the information contained in Accident Bulletin No. 32 of the Interstate Commerce Commission, covering the period of three months ending June 30, 1909. Both in the quarter and year ending June 30, 1909, the statistics show a decrease in casualties. The total number of passengers and employees killed in train accidents, such as collisions and derailments, is 99 for this quarter, the lowest ever recorded in these bulletins.

It is difficult to explain or give any reasons for the decrease in casualties, but we may conclude that operating methods are being improved and roadway is being constructed and maintained better than in past years.

Signaling methods and appliances have been improved and in many cases are automatic. The automatic block system is being installed on many miles of track and it seems that the more dangerous sections of the lines, where traffic is heaviest, are given first attention. The several railroad associations are gradually perfecting a system of signals which is to give the least number of indications. The requisite indications are difficult to determine, bearing in mind that the enginemen must be fully informed with the automatic system and still must not be confused by a multiplicity of indications through home and distant signals to which may be attached a variety of meanings.

With regard to roadway there are three points which we might now call to mind that are having an effect upon railroad accidents. In the first place when relaying steel heavier rails are replacing the old standards. The weights of rail which are now generally used are 85, 90 and 100 lbs. In this connection it has been realized that track renewals will be less expensive if the roadway is well ballasted, and therefore ballasting is now more systematic even so far as materials are concerned. The tie question also enters into this problem, but it will suffice to say in recent years the investigation of woods and the processes of preservation of the softer varieties have secured results. There is also an extended use of tie plates, rail braces, etc., and an improvement in the laying and construction of frogs and switches.

The second point is the double tracking of main line, which eliminates some of the hazards and prevents the large number of butting collisions.

The third point is the elimination of grades and curves. In recent months we have published items on the work of the Pennsylvania along this line. The Pennsylvania and New York Central lines offer good examples because they have necessarily given more attention to grade and curvature on account of the low time schedules, particularly on their New York-Chicago trains.

Terminal Freight Handling

The attention of our readers is called to a valuable paper by H. McL. Harding on the subject, "Terminal Freight Handling by Electrical Machinery," which was read before the St. Louis Railway Club and printed in their October proceedings. The secretary of this association is B. W. Frauenthal, general ticket agent, Union Station, St. Louis, Mo. One concluding paragraph, which follows, indicates in a way the purpose of the paper which includes data from all principal points in the United States and Europe.

"In the light of what has been done in handling package freight abroad, and the knowledge furnished the writer by American railway engineers as to the requirements in the United States, together with his own experience and his latest researches, it seems conclusive that the essential fundamental principles are that the conveying must be overhead and that the motive power must be electricity.

American Association of Railroad Superintendents

The Central Association of Railroad Officers, at their twenty-second annual meeting, held at Cincinnati, O., September 22 and 23, 1909, adopted a new constitution. These new "Articles of Association and By-Laws," as they are called, it is felt will broaden the scope and effectiveness of the organization. The name is changed to "The American Association of Railroad Superintendents."

The object of the organization is stated to be "the development and solution of problems connected with railroad operation, but more particularly co-operation and unanimity of action in such matters at junction and terminal points common to its members." It is also provided that "Matters of large importance, involving action beyond the authority of its members, shall be referred to the American Railway Association with the recommendation of this association."

Two standing committees are provided for; one to be known as the Transportation Committee, whose duty it will be to "report upon questions affecting transportation, such as train rules, yard service, freight house service, etc."; and the other as the Interchange Car Inspection Committee, "to report on all matters pertaining to interchange car inspection, loading and adjustment of lading, icing, etc."

The membership, as the name indicates, will consist of superintendents, or officers performing the duties of the superintendent where the road has no officer with that title; but, "Any official of a railroad whose superintendent is a member will be admitted to the sessions and may join in the discussions, or serve on the committees of the association."

Two regular meetings a year are provided for, falling on the third Friday in March and September, and the first meeting under the new by-laws, it was decided by the association, shall be held at Chicago, Ill.

The following officers were elected for the ensuing year: President, J. A. Somerville, superintendent terminals, Missouri Pacific Ry., Kansas City, Mo.; first vice president, Brent Arnold, superintendent, Louisville & Nashville R. R., Cincinnati, Ohio; second vice-president, S. M. Russell, superintendent, Toledo, Peoria & Western Ry., Peoria, Ill.; secretary-treasurer, O. G. Fetter, Cincinnati.

Best Organization for Railway Bridge and Building Department

In the preparation of a plan of an organization that will be for the best interests of a Railway Bridge & Building Department, your committee has solicited the opinions and views of a large number of the members of this organization, which has materially assisted in outlining the plan submitted.

In preparing this plan we have kept in view the thought that the organization which will secure the best results for the railway company as a whole is the best organization for the B. & B. department; as the relations between the B. & B. and the road department are so close we believe the best results can be secured by having both under the same head.

We have prepared diagrams showing an organization suitable for railroads having 1,000 miles or less, 3,000 miles and 6,000 miles of track. For a railroad having 1,000 miles or less we have shown the head of the B. & B. department as chief engineer. To him report one or two supervisors who are in charge of the B. & B. foremen and water service men.

For a railroad having 3,000 miles of track we have shown as B. & B. department head a chief engineer with an engineer B. & B. as a member of his staff, it being the duty of the staff officer to furnish plans and look after the execution of the work while the chief engineer directs the policy. Reporting to the chief engineer is an engineer maintenance of way, to whom six division engineers report, who in turn each have a supervisor of B. & B., who is in charge of the B. & B. foremen and water service men.

For a railroad having 6,000 miles of track we believe the following organization will be very effective:

Chief engineer is the head with an engineer B. & B. as a member of his staff, to whom report a superintendent of bridges, superintendent of buildings, superintendent of water service, and supervisor of scales, each of these having two inspectors. Reporting directly to the chief engineer are two engineers maintenance of way, each having six division engineers and each division engineer having one supervisor of bridges and buildings who is in charge of the B. & B. foremen, water service and scale men, each B. & B. foreman having a district of about 125 track miles. Under each supervisor is a water service foreman with an assistant to look after all repairs to water stations, and one thoroughly competent scale carpenter to look after all repairs to scales.

A road of this size should be properly equipped with sufficient tools to enable the superintendent of bridges to have a force in

*Report of Committee No. 3 of the American Railway Bridge and Building Association.

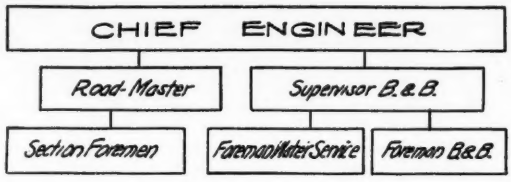


DIAGRAM NO. 1
PROPOSED
BRIDGE & BUILDING DEPT. ORGANIZATION
FOR A RAILROAD HAVING 1000 MILES OF TRACK

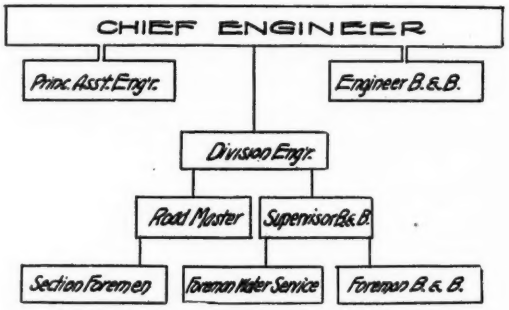


DIAGRAM NO. 2
PROPOSED
BRIDGE & BUILDING DEPT. ORGANIZATION
FOR A RAILROAD HAVING 3000 MILES OF TRACK

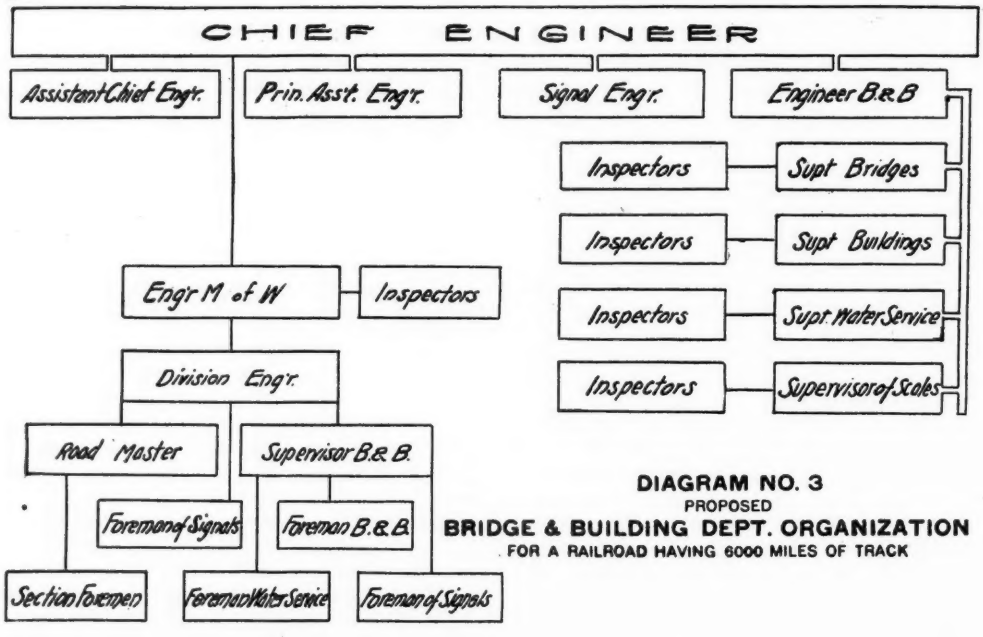


DIAGRAM NO. 3
PROPOSED
BRIDGE & BUILDING DEPT. ORGANIZATION
FOR A RAILROAD HAVING 6000 MILES OF TRACK

the field for the construction of culverts, masonry and erection of steel bridges.

The superintendent of buildings and superintendent of water service should also have sufficient force to handle all new work in their respective lines. This applies to new lines as well as existing ones.

On account of the local conditions it is impracticable to state any exact number of miles an organization will fit, but we believe a plan submitted with such variations as these conditions warrant will form the best organization for a railway bridge and building department.

Coaling Stations and Cinder Pits

The committee has found such a multiplicity of types of structures in use, that the limit of this paper will not permit of anything like an exhausted discussion of them. Add to this the numerous modifications of the various types and the lack of definite information, was the committee's apology for the incompleteness of the report.

While the committee recognizes the intimate relation existing between coaling stations and cinder pits in the economic operation of railways, we feel that the whole subject covers too much ground for one report. The committee therefore recommends that for future reports the subject be divided into two component parts.

The importance of economical handling of coal is a matter that deserves a good deal of attention. The railroads of this country consume about 115,000,000 tons of coal per annum. A saving of one per cent per ton would amount to $1,150,000. This is equivalent to about $3.50 per mile or greater.

COALING STATIONS.

The subject of coaling stations will be presented under the five following general heads:

1. Derrick Coaling Stations.
2. Chute Coaling Stations.
3. Clam Shell.
4. Mechanical.
5. Miscellaneous.

One of the most common types of derrick coaling stations is shown on plate I. The derrick is shown more in detail on plate 2.

When the amount of coal consumed per month is small, this method of handling the same has proved satisfactory. The coal is first shoveled from cars into the shed, and from there into buckets as it is wanted. The buckets are transported from the shed to the derrick on the small car shown on plate 1. The buckets are hoisted to platforms A or B by means of a derrick operated by a winch as shown on plate 1. In most cases on the Chicago, Milwaukee & St. Paul this winch is placed on the brace and not on the mast of the derrick. On the mast an air cylinder is fitted for hoisting the buckets. When air is used platforms A and B are omitted, and the coal is hoisted from the level of the loading floor. The air for operating the derricks is taken from the locomotive that is being coaled.

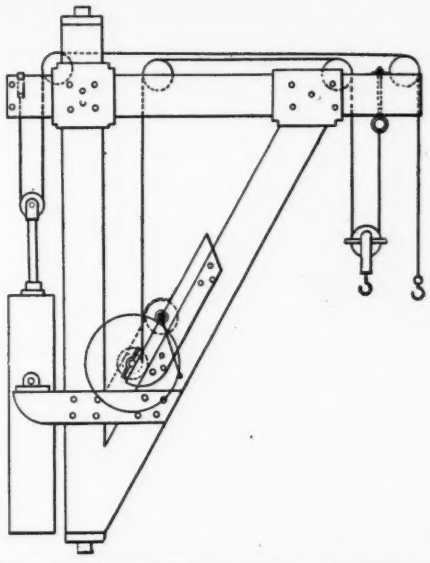


Plate 2.—Coaling Derrick for Hand or Air Power

At some of the stations provision is made for shoveling direct from the cars to the buckets. These buckets hold one-half ton. In some cases it is found economical to shovel direct from the cars to the tender.

Where the amount of coal used is quite small the handling is usually done by the regular section forces. In most cases, however, one or two additional men are required.

Under the head of "chute" coaling stations we find a great variety of structures. The chute known as the White patent is the most common, especially on western roads. The general construction of this chute is shown on plates 3 and 4. Chutes may be on one or both sides of the shed, depending upon local conditions.

In most cases cars of coal are delivered to the plant by means of an incline in the locomotive. In most instances, however, a short, steep incline is constructed, and the cars are hauled up by means of the stationary engine cable. The coal is then shoveled into the chutes. When a locomotive takes coal the fireman or hostler opens the chute by means of a chain.

As a general rule, in coaling stations of this character a regular force of coal heavers is employed, a number of men, of course, depending on the quantity of coal handled. On account of the easy adaptability to local conditions this style of plant is in high favor, whether for handling large or small quantities of coal. Mr. Gagnon, of the Minneapolis and St. Louis Railway, reports this as being the most satisfactory type of coaling plant in use on that road. On the Chicago, Milwau-

* Report of Committee No. 13 of American Railway Bridge and Building Association.

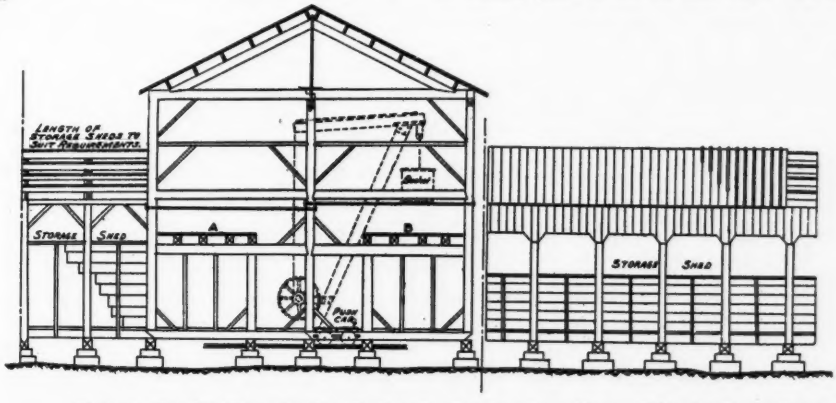


Plate 1.—Derrick Type Coaling Station for Loading from Storage Bins to Locomotives.

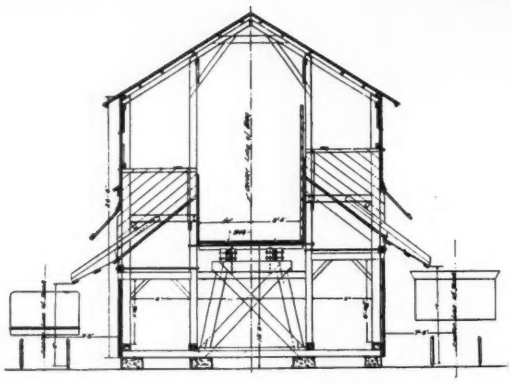


Plate 3.—White Patent Coaling Chute

kee & St. Paul Ry. it has been used extensively in the past, but is now being supplanted to considerable extent by numerous mechanical varieties. There are, however, some serious objections to this type of coaling stations in congested terminals. The large amount of room occupied is objectionable. Real estate is often high priced, and hence is usually wanted for other purposes. The item of maintenance is another objection. This is an all-wood structure and the high price of timber, considering the large amount used, makes the maintenance item a large one.

A six-pocket chute with 500 feet of trestle cost from $5,000 to $7,000. The cost of maintenance for the first ten years is very small, after that the charges will average about 10 per cent of the first cost per annum.

Under the third heading, that of clam shells, or steam shovels, we have a type not as common as the previous one, but one, nevertheless, that is in use on some of the large roads. The large features of this plant are a suitable tract of land, about on a level, or a little below the adjoining tracks. The ground is covered with tracks at suitable distance apart to accommodate the reach of the clam shell, which is self-propelling. The coal is usually unloaded from cars with the clam shell and piled as high as conditions will permit. The locomotives to be coaled are spotted on the adjoining tracks, or on tracks leading under the coal.

The expense of handling coal by this method is quite economical, but there are serious objections. The space occupied is in a great many cases prohibited. Another objection is the danger of spontaneous combustion. Also the coal exposed to the weather for a considerable length of time deteriorates in value. On the other hand, with a plant of this kind there is the advantage of having a large quantity of coal in storage. This is an important safeguard against shortage due to strikes and other incidents in railroad operation. A plant of this character is in operation via the Illinois Central Railroad at Dubuque, Iowa.

Another variety of the clam shell type is shown on Plate 5. This is one of the types used on the Intercolonial Ry. In this case a clam shell is operated by a locomotive crane and conveys the coal from the cars to the chutes. Hence, it is a combination of classes two and three. In some cases the clam shell is used to convey the coal direct from the cars to the tender. In any case where a locomotive crane is used for handling coal, economy would require that there be other available work for the crane, when not so employed.

On Plate 11 there is shown another variety of the clam shell type used on the Lake Shore & Michigan Southern Ry.

MECHANICAL COALING STATIONS.

In considering mechanical coaling plants we take up the subject concerning which there is considerable diversity of opinion. There are a number of these patent devices on the market. The general features of most of these are:

1. The dumping of coal from self-cleaning cars onto a breaking device. The unloading floors of these plants are usually on a level with the surrounding yard, or a little above.

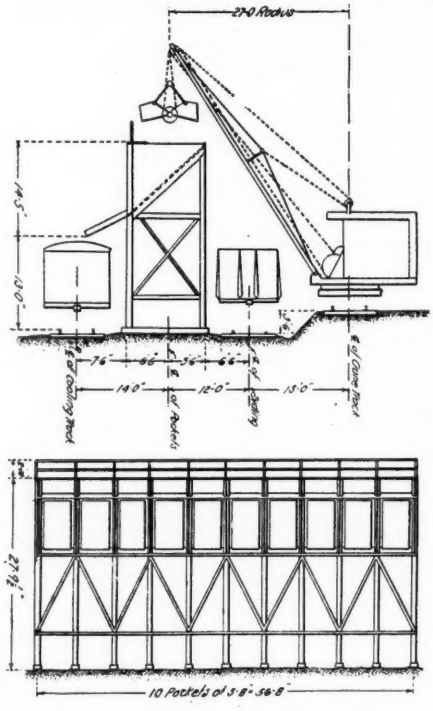


Plate 5.—Clam Shell Coaling Station

2. The hoisting of the crushed coal from below the track to a storage bin some distance above the track.

3. The drawing of the coal from the storage bin into chutes for delivery to locomotives.

4. The weighing of the coal.

Modifications of these general features occur in most of these patented devices. The breaking devices are either breaking bars or mechanical breakers. In order to avoid the necessity of always employing self-cleaning cars, provision should

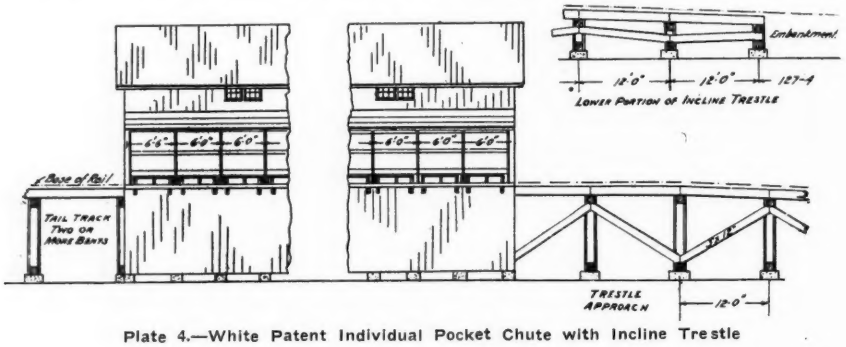


Plate 4.—White Patent Individual Pocket Chute with Incline Trestle

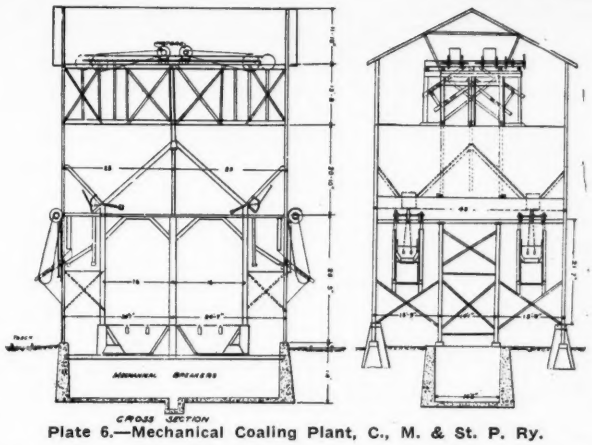


Plate 6.—Mechanical Coaling Plant, C., M. & St. P. Ry.

be made at these plants for unloading by hand, as emergencies frequently arise where self-cleaning cars are not available.

In discharging coal from self-cleaning cars it is sometimes dumped upon breaker bars, where it is broken to the required size by hand power. Most of the larger plants, however, are provided with mechanical breakers placed below the tracks. In either case, after the coal is broken it falls upon a conveyor which transports it to the elevator. This elevator carries the coal by means of buckets to the storage bin in the upper part of the building. Plate 6 shows the general features of one of these mechanical plants. Another variety of this type of coaling plant is shown on plate 7. This, as will be noticed, is a plant of much larger capacity. On the C. M. & St. P. Ry. there are several varieties of mechanical plants in use. There are some manufactured by Fairbanks, Morse & Company; others by the Link Belt Company; and still others in which the machinery has been purchased from various parties and assembled by the employees of the railway company. The committee has been advised that these plants have all proven satisfactory; some, however, to a greater degree than others.

In addition to the above types of coaling stations there is an endless variety of plants with their various modifications in use on almost every railroad in the country. In a great many cases there are local conditions which make a special type decidedly economical. One of these types is commonly used where there is a piece of high ground adjacent to a terminal and considerable coal is consumed, the high ground being used for storing large quantities of coal. The coal is unloaded either by hand or by clam shell. At right angles to the track, used by the locomotives when coaling, are a number of tracks for operating coal tipples. These coal tipples are loaded with coal at the storage pile and are then run to the edge of the embankment and discharged into the tender of the locomotives as required.

Another type used to some extent is where the coal cars are hauled up an incline by means of a gasoline engine and cable. The coal is then shoveled from the cars to small dump cars. From the rear end of the incline there is a bridge across the main tracks, above which there is a hopper for receiving the coal. The small dump cars are run out on the bridge and discharge their load into the hopper. This type of station is generally used for coaling freight trains between terminals. In other words it is merely a supply station for coaling locomotives while in transit with their trains.

In considering the type of coaling station to be used at any one point a good many elements enter. The question of ground room is, in a great many cases, an important consideration. This is especially true around busy terminals. The first cost of the plant must also be taken into account, together with the relative expense of operation and maintenance. It is also necessary to consider which type of plant will meet the requirements of traffic at each particular point. Another very important feature is the character of the cars that are available for handling the coal. For instance: A mechanical coaling plant requiring self-cleaning cars would be a very expensive affair where traffic was such that the cars would be hauled from the coaling stations to the mines, or any other distant point before receiving cargoes. In this connection it should also be borne in mind that the handling of coal loaded into box or stock cars is not only more expensive than when it is loaded in gondola cars, but the coal contains more slate than when loaded in gondolas. This is due to the fact that the slate pickers at the mines have not the opportunity to remove the slate. Box and stock cars are also much more liable to have an end knocked out than are gondolas. This damage to the ends of the cars is in most cases due to the force with which the coal is discharged from the mechanical loader at the mines. This is particularly true where the loader handles 1,000 or more tons per day.

It will be evident to anyone who has given the subject consideration, that it is out of the question to recommend any particular type of plant for general use. A plant that would be economical at one point might prove very expensive at another. There seems, however, to be a tendency to employ apparatus requiring a minimum number of men to handle it. This is not only true of the mechanical plants, in general, but applies equally well to all coaling stations. One great advantage in this is the lessening of danger from labor troubles,

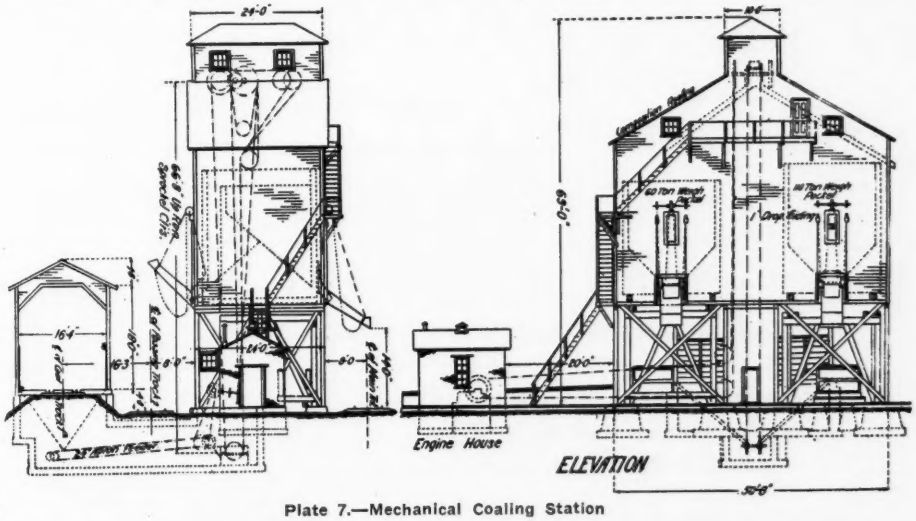


Plate 7.—Mechanical Coaling Station

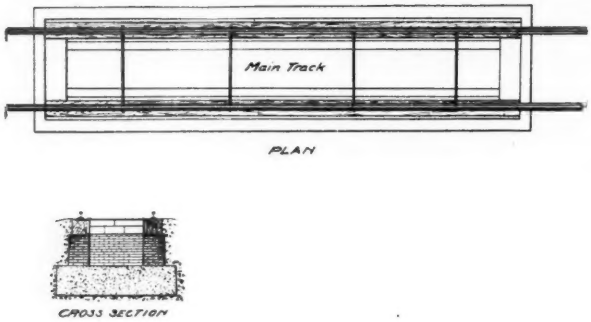


Plate 9.—Cinder Pit for Cleaning Engine Fires on Main Tracks, C., M. & St. P. Ry.

either strikes or shortage of help. Usually, however, the prime consideration is the decrease of fixed charges. The entire subject resolves itself into the question of what is the most economical plant to meet the conditions at any particular point. The committee has endeavored to call attention to some of the elements that should be considered in answering this question.

While it is not possible to fix the limits between which various types of coaling plants should be used, there are some general recommendations that can be made:

1. At terminals where the amount of coal used is small and time permits, the engines can be coaled by shoveling direct from the cars to the tenders.

2. Where the amount of coal handled does not exceed 100 tons per day a derrick and bucket plant seems advisable. If, however, the conditions are such that there is other work for a locomotive crane to do, that is frequently more desirable.

3. Where the amount of coal handled per day varies from 100 to 250 tons a clam shell and chute seems desirable, provided there is other work available for the clam shell.

4. Where more than 250 tons are used per day a trestle incline and chutes, or a mechanical plant, is probably the most desirable, the choice depending largely on local conditions.

Aside from the type of plant employed the character of the structure should have consideration. Reinforced concrete costs about 40 per cent more than heavy timber construction. The insurance charges are about four times as great for timber as for reinforced concrete. This difference in insurance amounts to about 15 per cent of the first cost of construction, leaving a difference of 25 per cent in favor of wood. There is, however, less liability of interruption to traffic from fire where fireproof materials are used. The cost of maintenance is materially reduced. It would, therefore, seem advisable to use fireproof structures where the volume of coal handled is very large. The question of adequate fire protection is certainly deserving of attention. Another important consideration, especially at mechanical coaling plants, is the quantity of coal slack resulting from the breaking of the coal.

Owing to different methods of accounting on different roads, the cost of handling is not a reliable guide in comparing the relative merits of various plants. Each station, with its local conditions, is a problem in itself. It should, therefore, be borne in mind that what is presented here is only a general guide. In making comparisons the cost item should include interest and depreciation, maintenance and operation, and a charge for cars used for storage purposes.

The following is a statement of such costs of handling coal as the committee was able to obtain, these data including the cost of operation only: For coaling stations of the derrick type 11½ cents per ton. The amount of coal handled at the plants from which these figures were obtained varies from 10 tons to 100 tons per day.

At chute coaling stations of the White patent type the expense is 4½ cents per ton; at the mechanical types of various makes 1½ cents to 3 cents per ton. These figures are true only of the particular stations investigated. Other plants in other localities might materially modify the figures.

REFERENCES.

Reference is made to the article on Auxiliary Coaling Stations, Page 78 of the Twelfth Proceedings.

The subject of Modern Coaling Stations and Cinder Pits also appears in the Sixteenth Proceedings on Page 101.

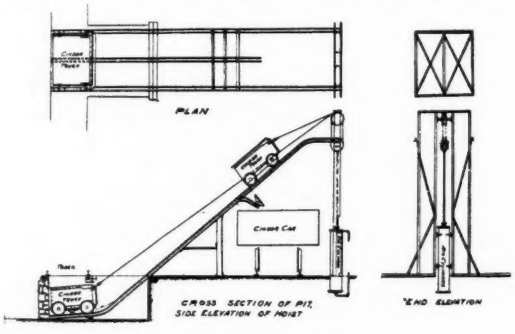


Plate 10.—Pneumatic Cinder Conveyor

CINDER PITS.

The economical handling of cinders and clinkers from locomotives is a subject well worthy of serious consideration. While it is not nearly so difficult a problem as that of handling coal, it nevertheless possesses some points of interest.

There seems to be an almost universal adherence to the open side pit operated by hand. While there are some modifications of this type of pit, the distinctive features are for the most part retained. This pit is shown on Plate 8. Some of the principal variations in this kind of pit are:

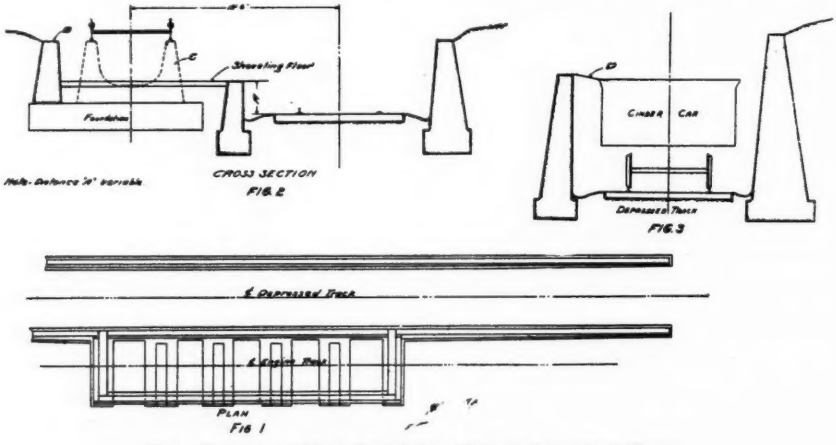


Plate 8.—General Plan for Cinder Pit and Depressed Track

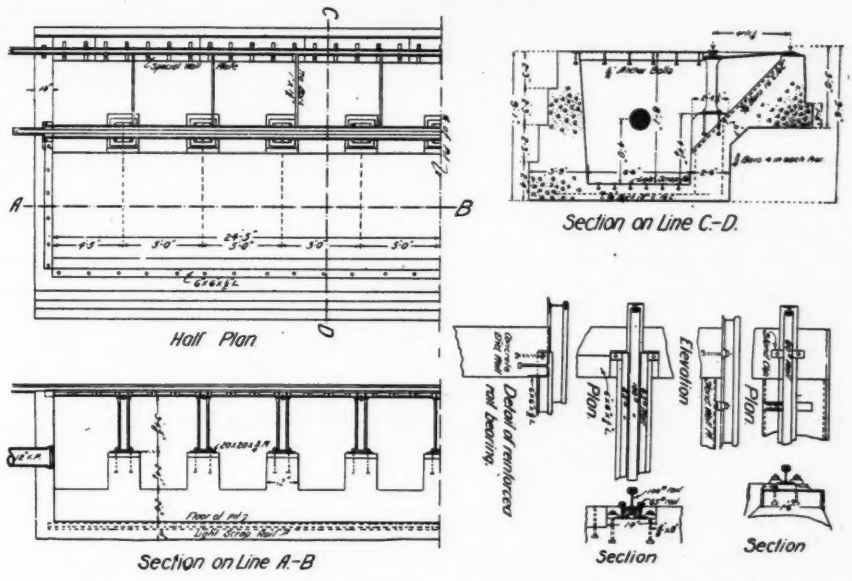


Plate 11.—Cinder Pit Lake Shore and Michigan Southern Ry., Hillsdale, Mich.

1. The variation of the distance "A" (Fig. 2, Plate 8).

2. Frequently one rail of the engine track is carried on top of wall "B."

3. Variation in the character of the support "C" for engine track. The distance "A" usually varies from about 2 ft. to 8 ft. Where drainage can be obtained for the depressed track, and the volume of cinders warrants the cost, it seems advisable to depress the track so as to bring tops of high gondolas slightly below the level of the shoveling floor. In this case an iron apron, "D," can be used to good advantage. Its use materially facilitates the handling of cinders, and also keeps the depressed track reasonably clean. Unfortunately, this arrangement can be used in comparatively few places, as usually adequate drainage can only be secured at prohibitive cost. The incline for the depressed track also takes up considerable room.

Plate 9 shows a type of pit used on main tracks for handling cinders between terminals, or at terminals where the amount of cinders is small. While this type of pit is a very good arrangement for such conditions, it cannot be used to advantage at a busy terminal. Owing to the usual location of these pits, it is generally necessary to keep them covered when not in use. For this purpose grates constructed from old engine flues make a satisfactory and economical covering.

Plate 10 shows a pneumatic cinder conveyor. In this case the track on which the cars are placed for receiving the cinders is on the same level with the entire engine track. The cinders from the engines are dumped into the iron car below the track. This car is then hauled up the incline by compressed air and automatically dumps the cinders into a gondola or a cinder dump. This incline is made ordinary T rails. The character of the whole construction is such that the maintenance cost is very low. In addition to this the drainage problem is easily solved owing to the shallowness of the pit under the engine track.

A device of this kind can be used only when the power is available for its operation. While Plate 10 shows a conveyor operated by air, there is no reason why other motive power could not be employed. This is a patented device and probably the manufacturers furnish them with any motive power desired.

The following table gives the result of a 14-day test of the economical value of this apparatus as compared with an open side pit:

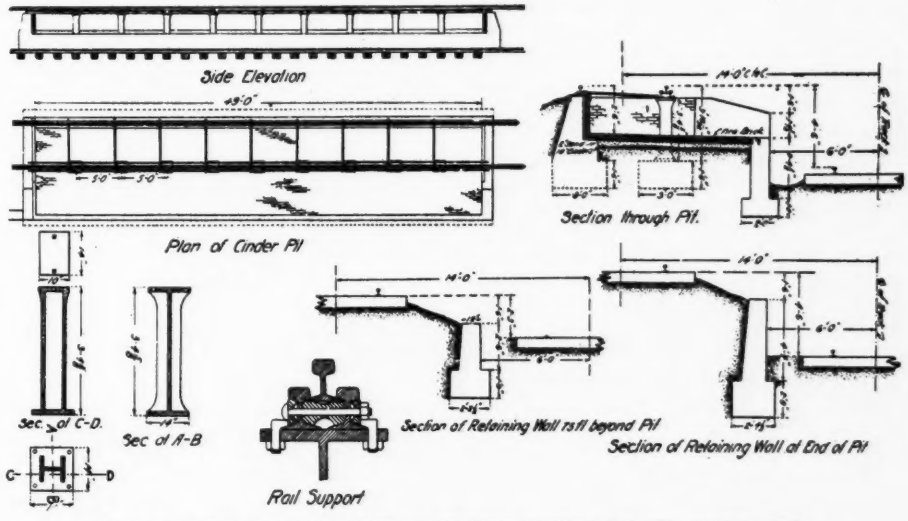

Side Elevation
Plan of Cinder Pit
Section through Pit.
Sec. of C-D.
Sec. of A-B
Section of Retaining Wall to fill beyond Pit
Section of Retaining Wall at End of Pit
Rail Support

Plate 12.—Cinder Pit, Lake Shore and Michigan Southern Ry., Ft. Wayne, Ind.

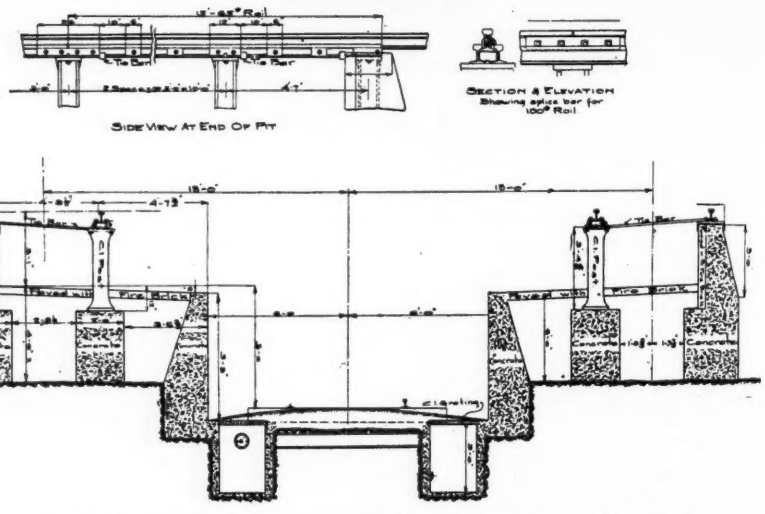


Plate 13.—Cinder Pit, Lake Shore and Michigan Southern Ry., Ashtabula, O.

	Pneumatic Conveyor.	Open Side pit	Total.
Switch Engines	3	424	427
8 wheel simple	357	85	442
10 wheel simple and larger	716	56	772
Total	1,076	565	1,641
Average per day, 14 days	76.9	40.4	117.2
Number of men employed	12	4	16
Wages per day	$22.27	$7.44	$29.71
Cost per engine (wages)	.29	.184	.254
Number of cars of cinders loaded.	30.75	13.75	44.5
Cu. yds. of cinders handled	1,417.6	207	1,714.6
Cost per cu. yd. of cinders handled	$ .22	$ .35	
For each man employed per day	8.4	5.3	7.6

From these figures it would appear that engines were handled over the pneumatic conveyor at 29 cents each, while over the open side pit the cost was 18.4 cents each. This statement, however, is not a fair comparison of the two schemes, as the engines handled over the pneumatic conveyor were nearly all heavy equipment, whereas, those handled over the open side pit were largely switch engines and other light types. From the yards of cinders handled it is seen that the heavy equipment averaged 1.3 cubic yards of cinders per locomotive, while the engines handled over the open pit averaged only .53 cubic yards. Then again, if we figure the cost of handling cinders we find that at the pneumatic conveyor the cost was 22 cents per yard while at the open side pit it was 35 cents per yard.

Neither the cost per engine nor the cost per cubic yard for handling cinders, when taken separately, is a fair basis for comparison in this case. A fair comparison can only be obtained by handling the same equipment over the two plants. With these two sets of figures, however, it seems there is very little, if any, economy in using a pneumatic conveyor as compared with the open side pit. This was probably due to the fact that the fire knockers were not continuously employed at the conveyor. It would therefore mean no additional labor cost for these men to load the cinders when not engaged in cleaning engines. The time between cleaning engines was not sufficient to allow these men to be withdrawn from the conveyor and employed at other work. Therefore all of their time was charged to handling cinders whether they were busy or not. It is quite possible that under other conditions the pneumatic conveyor would furnish more favorable results.

The pits shown on Plates 8, 9, 12 and 13 are usually constructed with masonry walls, hard burned brick, stone or concrete being generally employed. Fire brick are frequently used for the shoveling floor and walls, as shown on Plates 12 and 13. Hard burned brick appear to be giving good satisfaction as they stand the heat from the cinders and chilling from cold weather better than stone or concrete. This is especially true of the shoveling floor. A recent examination of pits constructed with concrete walls showed that in from two to five years the walls were subjected to hot cinders had disintegrated to a depth of from one to three inches. It is also a well-known fact that stone masonry disintegrates under such conditions. It is therefore the opinion of the committee that hard-burned brick, or fire brick, are satisfactory materials for such parts of the pits as come in contact with hot cinders. For the other walls of the pits brick, stone or concrete have given good results. Where stone or concrete walls have become disintegrated from the action of hot cinders and cold water it is frequently possible to protect them from further damage by facing them with a single course of hard-burned brick or fire brick.

Owing to the rapid wear on the shoveling floor a material should be used that permits of easy repair; brick is good for this use. In some instances the shoveling floor is made of concrete and placed 6 in. below the required height. When the concrete floor has worn out a course of hard-burned brick or fire brick, set on edge, is laid over it.

From such information as the committee has been able to secure, it is their opinion that the open side pit is the most satisfactory method of handling cinders from locomotives under ordinary conditions at terminals. Special conditions, however, might justify other methods.

Attention is called to the subject of Cinder Pits on page 101 of the Sixteenth Proceedings.

The first six months of the current fiscal year of the Westinghouse Machine Company, which ended last month, showed a business volume representing the second largest in the history of the company for a similar period. From present indications, it is confidently expected that the next six months will, however, show a much better result. This is due to the fact that business conditions generally are constantly improving; and also because the company has taken on several new lines of product within the last year, now fully developed, and the exploitation of which is greatly enhancing the volume of output. Indeed, 40 per cent of the business done by the company in recent months is represented by these new lines. In addition, the revival of the electric railway business from the financial depression is the source of many new orders which the company is now obtaining.

The Bucyrus Locomotive Pile Driver

The machine described in this paper is of some engineering interest as the most substantial and complete railway pile driver yet produced. Its special claims to consideration as a new development in mechanical engineering, however, lie in the unusual arrangement and strength of the self-propelling mechanism, and in the self-contained hydraulic turntable, whereby the entire machine, including trucks, is quickly lifted clear of the rails and turned end for end. The propelling engines, mounted on the car body and delivering more than 250 h. p., are connected to the axles of ordinary bogie trucks without interfering with the movements of the trucks in turning curves, passing over frogs, and the like.

The machine was designed to meet the requirement of the Atchison, Topeka & Santa Fe Railway system, for a pile driver capable of climbing any grade on their line and hauling its own cars of piles, tools, etc. The self-propelling pile drivers built hitherto are capable of moving themselves for short distances while at work, but from lack of sufficient steam capacity as well as engine power must have a locomotive in constant attendance. The services of this locomotive are usually charged against the bridge department of a railway at the rate of from $20 to $30 per day. After having used several of the ordinary self-propelling machines, A. F. Robinson, bridge engineer of the Santa Fe system, prepared specifications calling for a pile driver of much higher propelling power. This resulted in the designing by the Bucyrus Company of the machine herein described, which has been in active service on the Santa Fe lines since January, 1909.

The general appearance of the machine is shown in the illustrations. The counterweight on the opposite side of the swinging frame balances the weight of the leaders, keeping the machine always in a stable condition. In this position a pile can be driven 19 ft. from the center of the track.

With the machine standing on its hydraulic turntable with all wheels in the air and without any blocking the pile was picked up, put in place in the leaders and driven at a distance of 32 ft. from the center of the track. It was not desirable to drive this pile all the way in and the leaders were therefore backed down to clear the partially driven pile. The principal use of the hydraulic turntable, which will be described later on, is to turn the machine end for end when there is no railway turntable or "Y" available.

Fig. 1 shows the general arrangement of machinery. The car is 40 ft. long, built entirely of structural steel and steel castings. On the front end is mounted the swinging frame consisting of a pair of parallel trusses supporting the leaders at one end and a counterweight at the other end with the necessary parts for raising and lowering the leaders and swinging the entire frame to the right or left at right angles to the car body. This frame is swung by a large worm wheel, which also serves to raise and lower the leaders.

The latter operations are accomplished by means of the long worm-wheel hub projecting upward through the center pintle upon which the swinging frame revolves, a double-grooved sheave or drum being keyed to the upper end of the worm-wheel hub. This drum is provided with a clutch by which it can be engaged with the main base plate of the revolving frame. When this clutch engages with the swinging frame the latter moves with the worm wheel. When the clutch is out of engagement, however, and a brake is applied between the car body and the swinging frame, the revolution of the worm wheel does not carry the swinging frame with it, but merely turns the drum, which is keyed to the worm wheel.

The ropes leading from the drum to either end of the revolving frame are so arranged as to raise or lower the leaders. The details of the worm wheel, drum, clutch, etc., are clearly shown in Fig. 2. This figure also shows a large circular base plate on the car, for supporting the weight of the revolving frame. The latter is provided with four conical rollers which rest upon the finished upper surface of the base plate.

From Fig. 1 it may be seen that the leaders are mounted on a leader-raising frame by means of a pivot near the center of the leaders. A screw and nut device takes hold of the leader

*From the American Society of Mechanical Engineers proceedings by Walter Ferris.

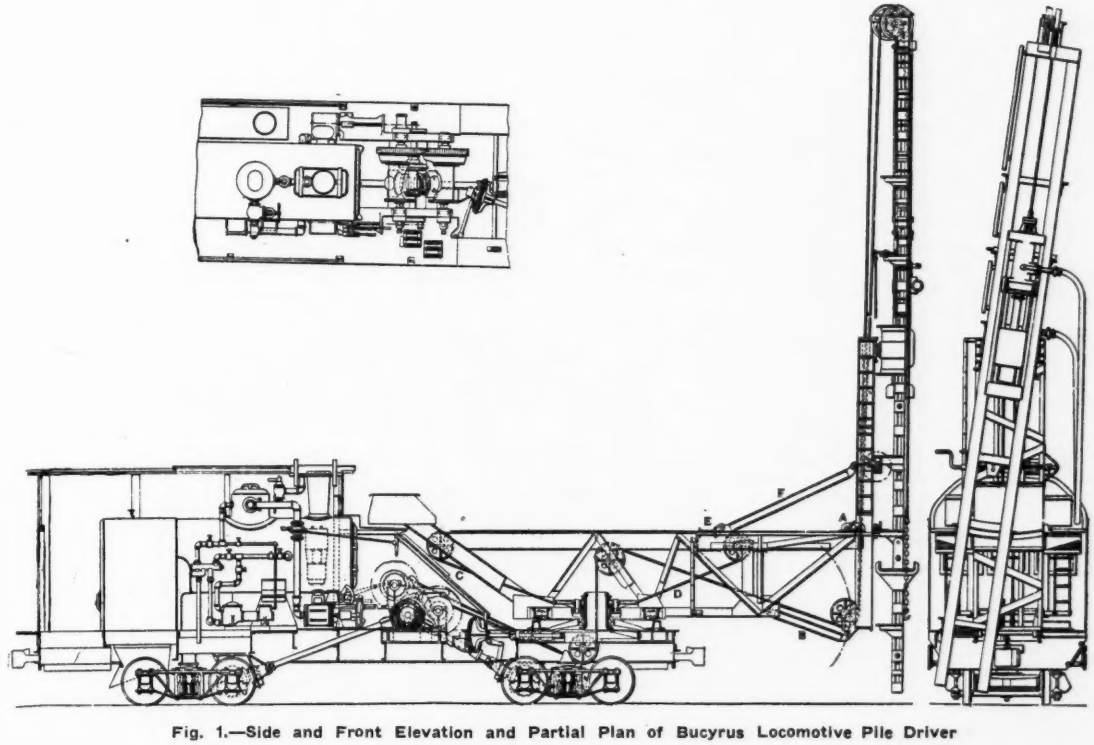


Fig. 1.—Side and Front Elevation and Partial Plan of Bucyrus Locomotive Pile Driver

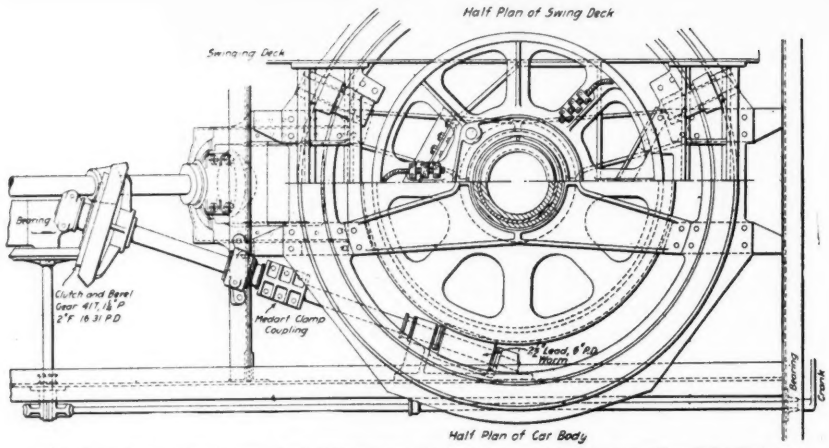


Fig. 2.—Plan of Swinging and Propelling Mechanism of the Locomotive Pile Driver

some distance below the pivot and with this they can be inclined either to right or left so as to drive batter piles. The arrangement for raising and lowering the leaders acts directly upon the raising frame, which is carried by two rolling trucks A which roll on the top of the upper chords of the swinging frame, while the radius arm B takes hold of the lower end of the raising frame, causing it to move in the arc of a circle as indicated. The ropes C and D over the drum pass around suitable idler sheaves and are anchored to the sliding crosshead E forming a closed circuit. From this crosshead the raising arms F take hold of the raising frame, transmitting the movement of the crosshead to the latter. The hammer-hoist rope, pile-hoist rope and steam pipe (the last-named is not shown) run up from the car body to the swinging frame through the large hollow hub of the swinging worm wheel. The steam pipe is on the center and the ropes are so close on either side that they work equally well with the leaders in any position with regard to the car body.

The main engines are 11 in. by 12, with double cylinders and Stephenson link motion. From the crank shaft the two drums for the pile-hoist and hammer-hoist lines are geared in the usual manner with cone friction clutches. The engines, however, are much more powerful than would be required for these drums. The propelling gearing consists of two inclined shafts leading from the crank shaft of the engine to the rear axle of the forward truck and the forward axle of the rear truck. From Fig. 3 it will be seen that each of these shafts carries on its upper end two bevel gears, while the crank shaft carries a sliding sleeve with a small bevel gear on one end and a large one on the other end, the two meshing respectively with the two pairs on the inclined driving shafts. By sliding the sleeve to one end or the other a fast or slow propelling ratio is obtained.

With the fast gear, on level or moderate grades and with moderate loads, the machine can readily be driven at 25 miles per hour and has been driven at 30 miles per hour. With the slow gear the engines are powerful enough to slip the two driving axles and thus obtain all the tractive force that can be had with about 80,000 lb. weight on drivers. The machine can thus be used effectively as a switching engine and will readily haul its own weight with considerable additional load over grades of 1½ per cent or more. The acceptance-test of the first machine built was a run of 32 miles up a grade averaging 75 ft. to the mile, with a maximum of 97 ft. to the mile.

The lower ends of the inclined propelling shafts shown in Fig. 1 are provided with bevel pinions. These pinions mesh with bevel gears cast in one piece with large sleeves, as shown in Fig. 3. These sleeves surround the driving axles, a cored hole through the middle of the sleeves 10 in. in diameter providing about 2 in. clearance around the axles. The sleeves are supported by brackets rigidly attached to car body with babbitted bearings. All this gearing is fastened to the car body only and remains in line without regard to the swivelling of the trucks.

The connection by which driving torque is communicated from the propelling sleeves to the axles is also shown in Fig. 3. It consists of a modified type of universal joint so arranged that there is nothing to interfere with the axle passing through the middle. The propelling sleeve carries at one end a large flange with lugs supporting two pins G; these pins engaging with two bronze bushed lugs H formed on the inner side of the toggle casting. On its outer side it carries another pair of lugs J on an axis at right angles to the axis of the pins G and these lugs J are connected to a U-shaped driving yoke K. The open end of this yoke is again pin-connected to a bracket L which is keyed to the axle.

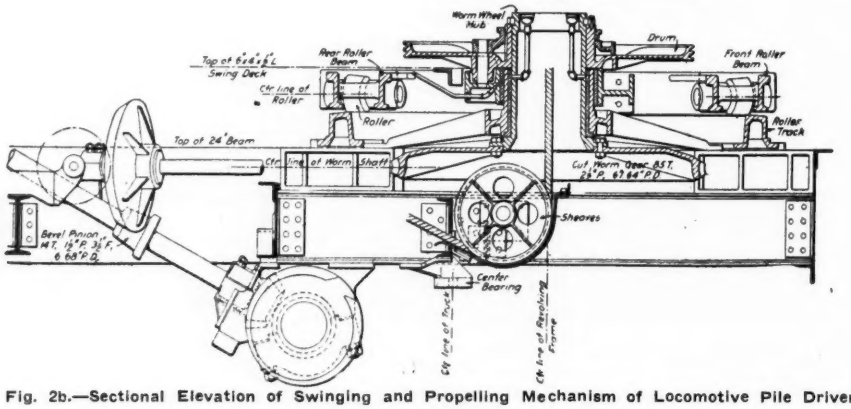


Fig. 2b.—Sectional Elevation of Swinging and Propelling Mechanism of Locomotive Pile Driver

Both pins, G and M are made much longer than the lugs which engage them to permit end play due to the displacements of the axle, as shown on the plan view in Fig. 3. As these two pins axis are at right angles to each other their combined slip will take care of any movement of translation, while the combined revolution of the parts around the pins G, M and N provides for any possible twisting. The wearing parts involved are six steel pins and six bronzed bushings, all the same size, and all parts are so made that the wearing surfaces can be replaced without taking the truck from under the machine. The pins are made hollow and are packed for continuous lubrication.

The method of detaching the driving gears when it is desirable to ship the pile driver in the freight train is slightly indicated in Fig. 1, at the rear axle of the front truck, where an operating lever is shown taking hold of the bearing which supports the bevel pinion at the lower end of the forward driving shed. This bearing in the pinion are mounted in the sliding support, which enables the pinion to be drawn out of mesh with bevel gear, permitting the propelling sleeves and gears shown in Fig. 3 to revolve freely with no gears in mesh. Same arrangement is provided on the rear truck.

In order to provide the necessary steam capacity for these propelling requirements, the boiler required is nearly three times the size of those ordinarily furnished for pile drivers. The boiler is of the locomotive type, 54 in. in diameter, 15 ft. 9 in. long, having about 800 sq. ft. of heating surface and designed for 175 lb. pressure. This pressure is required only for steam economy on propelling runs. As the engines are so large that all the ordinary movements of the machine can be made with 100 lb. pressure.

One of the striking features of the machine is the hydraulic turntable. It is frequently very important that a pile driver should be able to turn end for end or else to work at either end indifferently. The latter plan requires that the boiler and pile-driving machinery shall be mounted upon a swinging deck, which can be turned through a full circle and reach either end of the car. This plan has been thoroughly tried and is satisfactory as far as pile driving is concerned, but makes it impossible to get a sufficiently powerful and reliable propelling gear, between the engines and the trucks. In the new machine, therefore, pile-driving apparatus is mounted on the car body where it can work at one end only, thus obtaining the powerful propelling drive already described. To reverse the machine the hydraulic lifting jack shown in Fig. 4 is attached underneath the car and under the center of gravity of the entire structure.

The jack consists of two ball-race castings having races about five feet in diameter provided with two-inch steel balls. The upper ball race is carried upon a set of four ball cranks or levers O, two on each side of the car, the ball cranks being pivoted upon brackets P attached to the main car beams. The upper ends of each pair of bell cranks are connected by a parallel rod, while the rear bell cranks on the two sides of the car are connected across by a heavy shaft Q. This arrangement compels all our bells to act in unison, and when they are operated by the hydraulic cylinders the four pins from which the upper ball race is suspended move up and down same distance, maintaining the turntable at all times parallel to the car, even though the center of gravity may be quite a distance away from the center of the turntable.

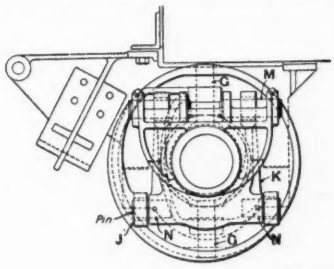
The system of bell cranks is operated by a pair of hydraulic cylinders 12 in. in diameter, having about 28-in. stroke. One cylinder is located on each side of the car. The cylinders have trunk pistons with sufficient area between the outside of the trunk and the bore of the cylinder to provide lifting force enough to raise the turntable away from the track and put it in shipping position. While lifting the car the pressure acts upon the full area of the 12-in. piston. The working pressure of about 200 lb. per sq. in. is provided by the boiler feed pump.

The lower ball race, which is suspended from the upper ball race by suitable clips, is also provided with a set of chair castings which rest on the rails and can readily be placed under the fourth jack screws, which are located in the four corners of the lower ball race. The lower ball race also carries a circular rack, while the upper ball race has a transverse shaft with a crank on each end and a double gear reduction to a swinging pinion which meshes with the rack on the lower ball race.

When the machine is to be turned it is necessary only to put the chair castings under the jack screws and run the latter down until they touch the chairs. The entire car is then raised by pumping water into the hydraulic cylinders and turned end for end by hand, two men working on each crank. In a high wind three men may be required on each crank. The entire operation occupies from 10 to 15 minutes.

The tests made since the first machine was put in operation indicate that it will fully come up to expectations. The first machine was built with slow gear only, having a maximum speed of 15 miles per hour. The results of its test on grades have already been mentioned. It has since been in constant use on the Western division of the Santa Fe and on heavy grades. The fast propelling gear herein described has now been added and two machines thus equipped have been built and shipped. On one of these, built for the Canadian Pacific Railway, the following speed test was made. The machine hauled an ordinary passenger car from South Milwaukee to Racine and return, a distance of 12.6 miles each way. The run to Racine was made in 31 minutes, an average speed of 24.4 miles per hour. The return run was made in 37 minutes, making an average speed of 20.5 miles per hour.

The shipping weight of the machine without the turntable as shown in Fig. 1, is about 147,000 lb.; with the turntable, about 160,000 lbs. It is equipped with either a No. 2 steam ham-



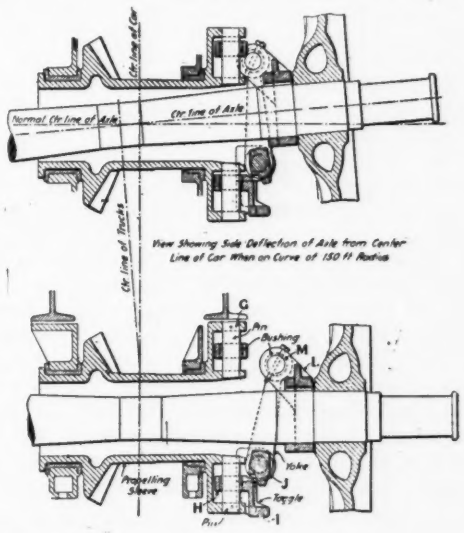


Fig. 3.—Sections and End View of Toggle Joint

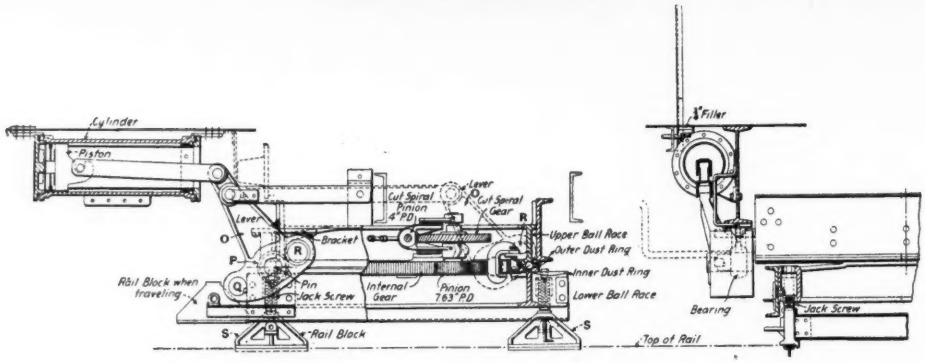


Fig. 4-A.—Side and Front Elevation of Hydraulic Turntable for Pile Driver

mer or a 3,500-lb. drop hammer, or both. The leaders are so made that either hammer can be used without change. The reach for driving piles is 18 ft. ahead of the center of the forward wheel, or 19 ft. on each side, as already mentioned, while with the turntable, 32 ft. on either side can be reached. The leaders are 40 ft. long. The construction is entirely of metal, except the house.

Report of Special Committee on Lightning Arresters*

The usual method of protecting signal appliances from lightning in the past has been to install spark gap arresters (usually of the "saw-tooth" type) between the line wires and the ground on each side of, and close to, the relay or other device to be protected as shown at S S in the diagram attached hereto in which R is a relay, the contacts of which it is desired to protect.

It has also been common practice to insert reactance or choke coils in the circuit between these spark gap arresters and the instruments to be protected, as shown at C C, on the theory that the inductance of these coils would resist the sudden rush of current which takes place over the line when a lightning stroke occurs in the neighborhood, damming this current up in front of the choke coils, so to speak, until the electromotive force becomes sufficiently high to break across the spark gap S S to earth.

Quite frequently grounded brass strips P P, placed in close proximity to the choke coils, are used to provide a path for the discharge from the choke coils themselves to these strips and thence to earth.

The use of fuses is generally unpopular because the blowing of a fuse puts the signals affected out of commission until a new fuse is installed, and also because it has been found that fuses sufficiently sensitive to afford protection are often burned out by discharges that would have caused no damage, thus increasing the number of unnecessary failures of the signal system and consequent delay to traffic to an extent that is intolerable. Fuses are therefore seldom used.

Whether lightning arresters are needed for the protection of relays and other instruments connected to the rails of the track has always been a disputed question, but sufficient evidence of damage to such instruments by static discharges from the rails has been obtained to satisfy the committee that lightning arresters should be used in these circuits as well as in the line wire circuits wherever atmospheric electrical disturbances are comparatively frequent or severe, and reasonable immunity therefrom is desired.

Various methods of grounding arresters have been tried but the best results seem to have been obtained either by driving an iron pipe into the ground or burying a copper plate two or three feet square, embedding same in coke or charcoal.

*Report of special committee of the Railway Signal Association.

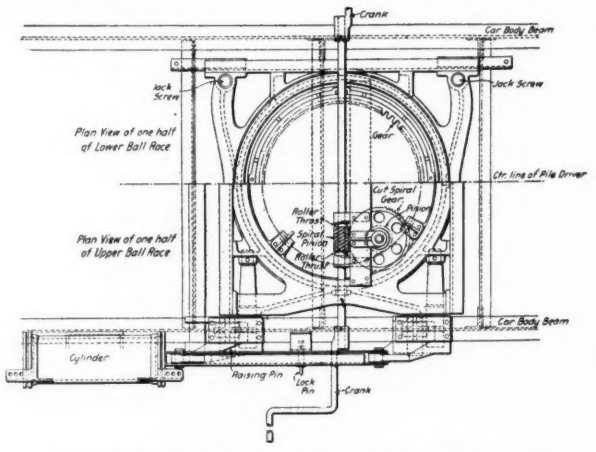


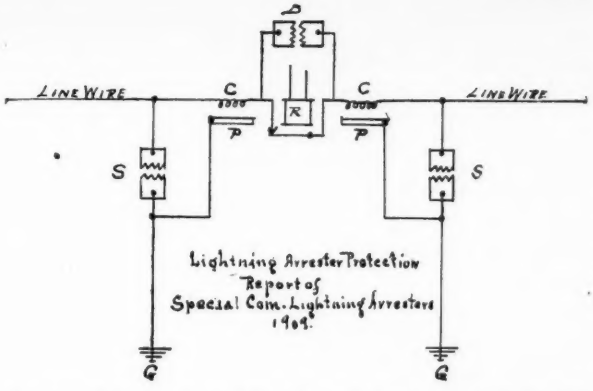
Fig. 4-B.—Plan of Hydraulic Turntable for Pile Driver

When a thunder cloud approaches the line wires, a static charge is induced on the latter higher than that of the ground. This difference of potential between the line wires and the earth may increase until it is sufficient to puncture the insulation of the relays and other devices at which these line wires terminate when a discharge will occur through these instruments with disastrous results.

The electrostatic stress in the line could be relieved by providing a permanent leak, such as a high resistance connection between the line wires and the earth, but such a leak would be liable to interfere with the proper working of the signal circuits in other ways.

Spark gap arresters connected between the line and the earth will prevent the static charge on the line reaching a dangerous pressure if the spark gap is made small enough to offer less other devices to be protected. The difficulty encountered in attempting to do this is that small particles of metal, cinders or other conducting materials are apt to lodge in the spark gap thereby permanently grounding the line which is liable to seriously affect the proper working of the signals, or, if the spark gap is made by mounting two metal plates a very small distance apart as in the ordinary saw tooth arrester, the discharge may fuse these two plates together. Even moisture between the plates may ground the circuit sufficiently to interfere with its safe working. The spark gap should therefore be so designed as to prevent the permanent grounding of the circuit from any of these causes.

Another difficulty experienced with the saw tooth arrester is the burning off of the serrated edges, thus widening the spark gap and increasing its resistance. Certain other substances, such as carbon, acquire a high resistance coating as a result of static discharges and are therefore unsuitable for use



in lightning arresters for signal circuits which should be capable of discharging repeatedly with unvarying efficiency.

With the low voltage used in automatic block systems and the electric locking and annunciator circuits of interlocking plants there is no danger of the battery current continuing to flow across the spark gap after the discharge, but in arresters intended for use on the control wires of electric interlocking plants, or on storage battery charging lines, some means of extinguishing the arc started by the lightning discharge, must be provided. All of the lightning arresters designed for the protection of electric light and power lines are provided with some means of accomplishing this, usually by cooling, or smothering the arc, or by means of a magnetic blow-out, or by the use of a non-inductive resistance in series with the gaps.

For relieving steady electrostatic pressure on the line probably the best arrangement of the spark gaps would be to space them at equi-distant intervals along the line. But when a lightning discharge occurs from one cloud or part of a cloud to another or to the earth in the neighborhood of the line, the electrostatic charge on the line readjusts itself to the new conditions by an oscillation or impulse seeking a path to the earth. At the Chicago meeting of the Association last March Mr. Creighton, in illustrating the action of these impulses or oscillations, demonstrated very clearly the need of locating the spark gaps near the instruments to be protected, as an impulse of moderate potential at the spark gap may build up so as to form an oscillation of much higher voltage farther along the line.

It is to assist in taking care of disturbances of this kind that the choke coil is of value and this value seems to be unquestioned provided the coil has sufficient inductance. A coil of twelve or fifteen turns, however, has so little inductance as to render it, in the opinion of the committee, practically worthless. The committee is also inclined to doubt whether the use of an iron core is of any value in increasing the inductance of the coil as the iron would not have time to become magnetized. Ground plates set to receive discharges direct from the choke coils as shown at P P in the diagram are of no value unless they are placed very close to the coils and if this is done a great deal of trouble is experienced from the coils coming in contact with the plates and permanently grounding the circuit. The use of such plates is therefore inadvisable, judging from the results of experience with arresters of this type which have been reported to the committee.

It has been suggested that, where two line wires approach a relay or other instrument from opposite directions as is frequently the case, a spark gap placed across the instrument as shown at B in the diagram might afford considerable protection by permitting discharges to proceed uninterruptedly along the line wires until they gradually dissipate or find a harmless path to the earth.

Another form of protection, which has been suggested but, so far as the committee has been able to learn, has never been tried in connection with any signal installation, is the grounded overhead wire utilizing the principle first advanced by Faraday that a grounded metal cage (Faraday's cage) enclosing the line wires or any other structure to be protected would afford the most complete protection possible against lightning.

One or more grounded overhead wires have been used for protection of quite a number of long distance power transmission lines with various results, the experience on the whole seeming to indicate that such wires properly installed would afford considerable protection. One of the most important requisites of such a protective wire is high conductivity. Wire of ample size should be used and thoroughly grounded at frequent intervals. At first barbed wire was used, but this gave considerable trouble from frequent breakage and it was found that plain galvanized iron wire was equally effective so far as protection was concerned. The results of some experiments indicated that such a wire was equally effective when strung below the line wires as when strung above them, but the best authorities recommended putting the protective wire over the line wires and high enough to form an angle not greater than 45 degrees with the outside wires.

The grounded overhead wire is probably the best protection against direct strokes of lightning that can be provided. The ordinary lightning arrester will not take care of direct strokes, but fortunately such strokes are rare, the discharge usually occurring between one cloud and another, or from a cloud to the earth, or between different parts of the same cloud, and in such cases the lightning arresters only have to take care of the disturbances caused in the circuits due to the induced charge on the line wire.

It is probable that poor ground connections are really responsible for more lightning trouble than inefficient lightning arresters. It is not only necessary to select a suitable spot for the ground plate (in permanently damp earth if possible) but the connections from the arresters to the ground plate should be as short and straight as possible. Sharp bends in ground connections should be avoided and loops or coils should never be allowed on account of their inductance. Some authorities even go so far as to specify that, where a pipe driven into the ground is used instead of a ground plate, the ground wire must be plugged into a cap screwed on the top of the pipe instead of being wrapped around and soldered to the pipe on account of the inductance of this wrapped portion of the wire. Copper wire of ample size should be used for all ground connections, No. 6 B. & S. or larger, being recommended, and every effort should be made to keep the resistance of the path for the lightning from the line to the earth as low as possible.

Technical Publications

"Fuel Tests with Illinois Coal," by L. P. Breckenridge and Paul Diserens, is issued by the Engineering Experiment Station of the University of Illinois as Circular No. 3. It consists of a compilation of data relating solely to the coals of the State of Illinois, selected from the complete reports of the government investigations on the fuels of the United States. Copies of Circular No. 3 may be obtained gratis upon application to W. F. M. Goss, director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

"Fuel Tests with Illinois Coal," issued as Circular No. 3 of the Engineering Experiment Station of the University of Illinois, presents the results of an elaborate series of tests conducted at the fuel testing plant of the United States Geological Survey. The circular is compiled by L. P. Breckenridge and Paul Diserens.. It deals only with coals taken from mines within the State of Illinois. The investigations described include steaming tests under boilers, gas producer tests, washing tests, coking tests, briquetting tests, and tests to determine composition and heating value. From the results stated it appears (1) that

the average calorific value of Illinois coal (ash and moisture free) is 14319 B. t. u.; (2) that its evaporative efficiency is but slightly affected by the moisture it contains; (3) that its evaporative efficiency decreases as the ash and sulphur content increases, and that when burned in a hand-fired furnace its evaporative efficiency decreases as the amount of fine coal contained in it increases; (4) the performance of Illinois coal in a gas producer compares favorably with that of any other bituminous coal tested at the U. S. G. S. laboratory. (5) One-fourth of all the samples tested may be used for the manufacture of coke; (6) briquetting improves the evaporative efficiency of Illinois coals only when the raw coal is in the form of slack or screenings. Copies of Circular No. 3 may be obtained gratis upon application to W. F. M. Goss, director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

Design of Material Yards, Platforms and Sheds

This report is extended only to material yards, platforms and sheds in the bridge and building department. In order to secure data for this report, one hundred and ten circular letters were sent to members, and as a result twelve replies were received. Being somewhat disappointed in the number of answers received, we do not wish to recommend any specific design or layout. We do not wish to censure the members for lack of interest in the subject, but we realize that the facilities and appliances for housing and caring for material in this department are of a provisional character and governed solely by conditions. For instance, we note from the replies received that on six roads the bridge and building departments handle and care for their respective material, two are operated jointly with the maintenance of way department and four by the storehouse or supply system. Hence the committee deems it advisable to give a summary of the replies and hopes that the discussion at the convention will develop an interest in the subject.

EXTRACTS FROM REPLIES.

J. P. Canty, Supervisor B. & B., Boston & Maine R. R.:

Our principal material yard is located at the headquarters of the division maintenance of way department, but we have two other smaller material yards at subdivision points for emergencies and general convenience.

The ground areas, tracks and buildings at the above mentioned points, used for the storage of material, were not originally designed for maintenance of way purposes and are, therefore, not well adapted for our needs. On many of the older eastern roads, as with us, quarters for these outfits are small shops, or portions of the same, abandoned by the mechanical departments. We have nothing to offer as examples of efficient layouts for the economical handling of maintenance of way material.

All of our material is either handled directly by hand or by hand power boom derricks, as is convenient. The greater portion of our material for bridge and building work is handled in a yard used jointly with the track maintenance of way forces and is under the supervision of a maintenance of way storekeeper.

H. H. Eggleston, Supt. B. & B., Toledo, St. Louis & Western R. R.:

Bridge and building material is placed together in our supply yards, where we have a track through the center, and the material piled on both sides on scaffolds the height of the floor of a flat car. Our water supply stock is all kept together in a shed and in the water supply tool cars on the line for emergency use. Our interlocikng and signal material is all kept in the supply cars with the gang. Our painting supplies are kept in the tool cars with the painting crew.

We have a small supply yard at headquarters with one track in the center, and platforms, lumber sheds, etc., on both sides of the track. Material is all handled by hand power, except in unloading heavy cast iron pipe, and unloading material of this kind we sometimes use the wrecking derrick.

Sheds for storing lumber should be built of cheap material and covered with prepared roofing. Bridge and building material is handled under the jurisdiction of the superintendent of bridges and buildings. We maintain a carpenter shop without power.

G. Aldrich, Supervisor New York, New Haven & Hartford R. R.:

We have no special design for yards and tracks. All of our material is handled by a general storekeeper assisted by district storekeepers, with stores located at different points on the road. Our light material is taken care of wholly by these storekeepers and we order from them as we need it. Our heavy material, which is classified as lumber, heavy cast iron pipe, standpipes, etc., is kept at headquarters on our various divisions.

In my particular case we have one yard which is near my headquarters where we carry most of the material which is kept in stock, carrying only a very small portion where the different gangs are located. We load and unload our material by hand unless the steam derrick should be in operation when needed.

R. H. Reid, Supervisor of Bridges, Lake Shore & Michigan Southern Ry.:

Materials Handled—Timber, piles, bolts, spikes, iron pipe, tools and general bridge supplies. Timber should be classified for size, length and kind, that is, whether pine, oak or fir, etc., and whether new, good second hand, or old.

On the Lake Shore we have two general material yards, where we keep a good supply of material used in ordinary bridge and trestle construction and maintenance.

After the location of material yard has been decided upon, tracks should be built through the yard about 40 feet apart, and parallel to each other, and if practicable straight, with switch connections at each end so that cars can be taken in or out at either end. I would have them approximately 40 feet apart in order to allow timber to be piled on both sides of the tracks, so as to make use of the space to the best advantage. The piles of timber should be kept at least 5 feet from the rails of the track, to avoid injury to men on the sides of cars, and also to permit passage way between cars and timber piles. The material piles should also be about 4 or 5 feet apart, to allow passage way between them, and to furnish greater safety in case of fire. Piling, when kept in stock, should be on elevated docks, where they can be rolled quickly from the pile dock onto the cars with the minimum expense, and when practicable, it is desired to unload piling on one side of the dock and load them from the other, so as to work off the older piles first, thus not to bury them under new ones.

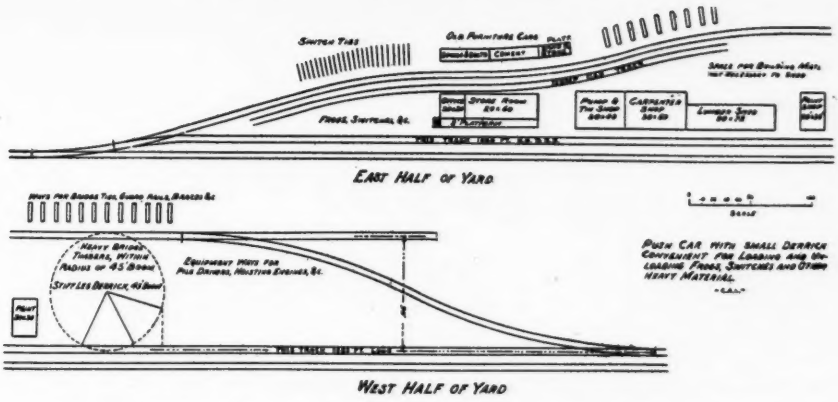
Different lengths of piling should be kept separate, varying by about 5-foot lengths, that is, one pile might contain stock from 28 to 32 feet in length, another from 33 to 37 feet, etc. If only a very small stock is to be carried a greater variety of lengths might be kept in one pile.

The size of the yard would depend on the variety of sizes and amount of stock to be carried.

R. J. McKee, Supervisor B. & B., Illinois Central R. R.:

Prior to one year ago each division on this road ordered and took care of its own material and we carried a sufficient amount of material to building one or two small depots, and the running repairs of the division, and enough bridge material to build from 500 to 600 feet of trestle. This material was kept at division headquarters, with small houses and sheds to take care of the building material, and each kind of material was piled separately, under cover. The bridge material was piled on skids along a track that was put in for that purpose, each

*Report of Committee of the American Railway Bridge and Building Association.



Proposed Layout for Maintenance of Way Yard, Mo. Pac. Ry.

kind piled separate, and generally all of it handled by hand, which costs from fifty cents to one dollar per thousand for handling. I do not consider it necessary to build platforms for piling lumber upon, as it is quite expensive and does not materially lessen the cost of handling. The shed should be substantially built, with a good roof; anything to keep the lumber dry will answer. Our present system of handling bridge and building material is through the supply department, which has supply yards at different points on the system.

W. T. Powell, Supt. B. & B., Colorado & Southern Ry.:

Our material yards are located at division points. At these places we have emergency cars loaded with sufficient stock to rebuild an ordinary 80-foot trestle. These cars are always ready to go to a washout or burnout.

We have one building which contains office, carpenter shop and two store rooms, one for bolts, nails and heavy hardware, and the other for builders' hardware and pump supplies. In line with this building we have a covered shed, 100 feet long, in which we keep finishing lumber. There are tracks on each side of this building. We also have tracks on each side of our heavy material.

All material is handled by hand except the very heaviest, which is handled by the yard track derrick, which is self-propelling and capable of handling five cars at a time.

Our sheds are boarded up on north side and the ends. They have no floors. Our platforms are elevated. All bridge and building material is handled by the bridge and building department.

A. A. Wolf, Chicago, Milwaukee & St. Paul Ry.:

On each division is kept, at the most convenient point, a small amount of material for emergency use. For the entire system a general stock is carried in the central yard for distribution to any point where needed. A large percentage of lumber, timber and piling is delivered from the mills or forests direct to the point where it is to be used, and consequently is not handled through the supply yard.

As only a small amount of material is handled through our local division yards, we do not require any particular arrangement of tracks; usually a small space of ground convenient to some already established side track serves the purpose.

Timber, piling and light steel are handled by hand, except at the central yard, where an industrial crane is in use to take care of everything that can be readily handled by two or three men.

We have locally on divisions no regularly maintained carpenter shop, but we have a small building where a local crew can repair or make small articles by hand, as needed on the division. We have at the central supply yard a mill equipped with machinery to surface any size material, resaw lumber, make siding, flooring, mouldings of all kinds, and in fact do almost any kind of work that can be done at the average planing mill. Besides, at this mill are framed wooden turntables, Howe trusses, windmill towers and other kindred structures. The machinery in the mill is operated entirely by electric motors and is divided into several units, so that electric current is used only when each individual unit is in operation.

R. J. Bruce, Supt. Buildings, Missouri Pacific Ry.:

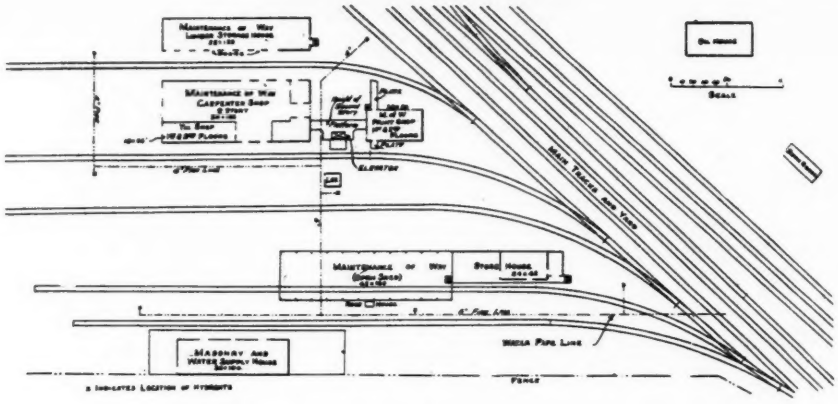
On our system everything in the maintenance of way department is handled at the same place, each division having a maintenance of way storekeeper, who reports to the division engineer, consequently the enclosed plan of proposed material yard would meet our requirements, while perhaps on some roads where the bridge and building material is kept separate from that of the track department it might not be entirely satisfactory. In planning any kind of material yard several things enter into it; generally, economy in handling material, along with convenience, is the first desire; economy of structures and fireproofing second.

We have on each division a storeroom and work shop, not especially arranged as all was, as is usual, added to some nucleus already existing, rather than carrying out a well-defined scheme from the ground up. We are, however, constantly improving along these lines, as a well-equipped shop and yard soon demonstrate the benefits to be derived from them and encourages the management to more liberal allowances for such improvements, for it cannot be expected that money will be spent on something that will not bring in returns by saving in labor and increasing output at the same time.

A. S. Markley, Master Carpenter, Chicago & Eastern Illinois R. R.:

We have no special design of yard or location of tracks. At each division point, one side track along the main track is made use of, from which to unload material. At the general yard, where a large supply and emergency supply is maintained (which is located at the headquarters of the master carpenter), one track along the main track and another 40 feet distant are used to unload timber and piling from, the latter being kept separate at one end of the yard, in piles, according to kind of wood and length; no piling is kept at the division points.

We have a self-propelling derrick car for handling material in the general yard. Unless there is a great deal of it, the loading at the division points is done by hand, but if occasion requires the derrick is sent to assist. The cost of handling, loading and unloading with the derrick varies from 85 cents to $1.50 per thousand feet. Where derrick car is used we put down old timbers for skidways, which are placed 10 or 12 inches above the ground, upon which to pile timber and piling. Where timber is moved by hand old timbers are placed on pile heads three feet above head of rail, and spaced to accommodate the different lengths. These should extend back from the track 30 to 40 feet. All layers should have 1 to 3-inch strips



Maintenance of Way Buildings and Yard, P. & L. E. R. R., McKees Rocks, Pa.

between them, with timbers placed one inch apart, all piled even at one end and parallel with the track. The entire surface of the ground should be well drained and covered with cinders to prevent weeds from growing. A small house should be provided to shelter men, and store tools used in loading and unloading, in case buildings are not in close proximity to the yard.

The character and size of shed depends on the amount of material to be cared for. For 400 or 500 miles of road a building 50x100 feet, and 20 feet high, with track in center, is sufficient. Floor is not necessary; lumber piled at right angles to track on each side. A second scaffold should be provided at a height of 12 feet upon which to pile light lumber, sash, doors and the like. Thirty feet of one end of this building should be used for a workshop; to have an abundance of windows, heated with steam, if possible, and a brick floor; work benches around outer walls, and racks overhead for storing moulding, furniture, etc. The workshop should be equipped with an 8-horsepower gasoline engine, universal woodworking machine, rip-saw, mortising and boring machine, drill, emery wheel and grindstone; with this equipment any ordinary work can be turned out quickly and economically.

Lumber, timber and a small quantity of hardware are handled on our road by the bridge and building department, under the direction of the master carpenter.

C. H. Soles, Supt. B. & B., Pittsburg & Lake Erie R. R.:

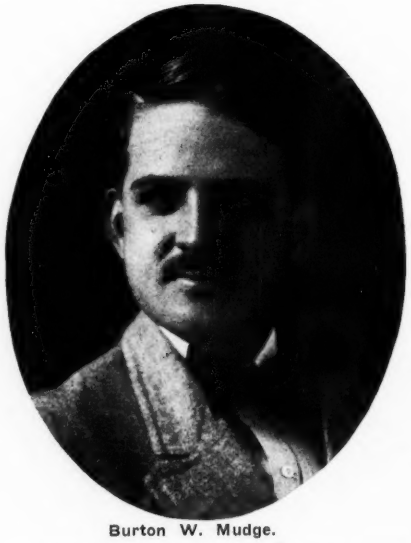
The accompanying illustration shows our layout of tracks and buildings. Lumber is piled as to sizes, the larger sizes close to tracks for convenience in handling. We use no power; all material handled by laborers. We have a double-decked storage house, 28x132 feet, in which all shop lumber is stored. On the north side of this building there is a platform as high as the deck of a car, where we build all small buildings that can be transported on a car. We find this to be a good feature, as buildings can be easily loaded when ready to send out. About 30 feet east of this is located the two-story carpenter shop, 54x132 feet, the first floor of which is divided into office for foreman, store room and tin shop; there is also on this floor a 30-h. p. electric motor, planer, rip and cut-off saws, drilling machine, etc. The second floor contains the carpenter shop, and on this floor is installed a 25-h. p. electric motor, operating universal wood worker, small planer, band saw, turning lathes, rip and cut-off saws, tenoning and moulding machine. North of this, and 50 feet distant, there is a two-story paint shop, connected by a bridge with the second story of carpenter shop, and on this floor is installed a 25-h. p. electric motor, operating to accommodate large stationary cases and office furniture. The first floor and cemented cellar of paint shop are used for the storage of paint and other material, and the second floor for painting. This yard also contains the water supply store house, shop and office, and the maintenance of way store house and yard.

All bridge and building material is handled by the bridge and building department.

A. Montzheimer, Chief Engineer, Elgin, Joliet & Eastern Ry.:

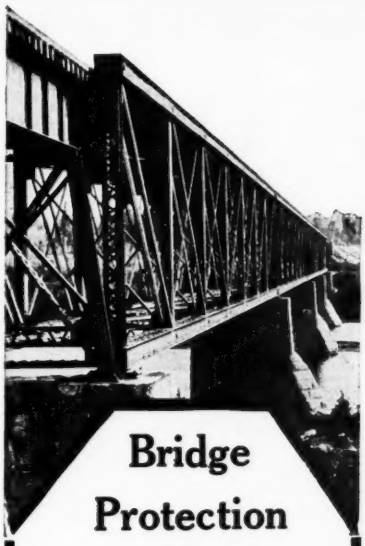
The best design, in my estimation, for a platform for any use is one made of concrete retaining walls, cinder fill and concrete floor. Where heavy trucking is to be done on platforms, if the floor is made 5 or 6 inches thick and given at least ¾ inch of rich top dressing, it will stand up under any sort of trucking. This is the style of platform that we put in at Gary store house, also for the floor inside of the house; this floor is holding up in first-class shape.

The Selling Side



Burton W. Mudge.

Burton W. Mudge has been in the railway supply business a little over a year, previous to which time he was employed in various capacities on the railroads in this country and for the past ten years has held the following positions: Train master's clerk with the Chicago & Northwestern Ry.; chief clerk to the general superintendent of the Santa Fe; chief clerk to the general superintendent then train master of the Colorado Southern lines; and later chief clerk and assistant to the general manager of the Rock Island, which position he resigned to engage in the railway supply business on Sept. 1, 1908. Though comparitively young in the supply field he has been advancing rapidly and his success is attributed to his marked activity in business.



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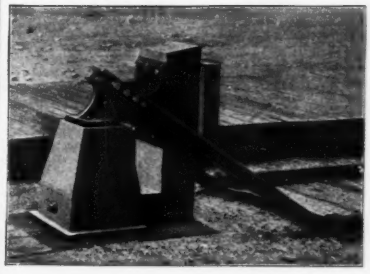

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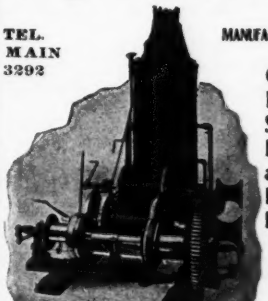

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GEO. J. CHARLTON, General Passenger Agent
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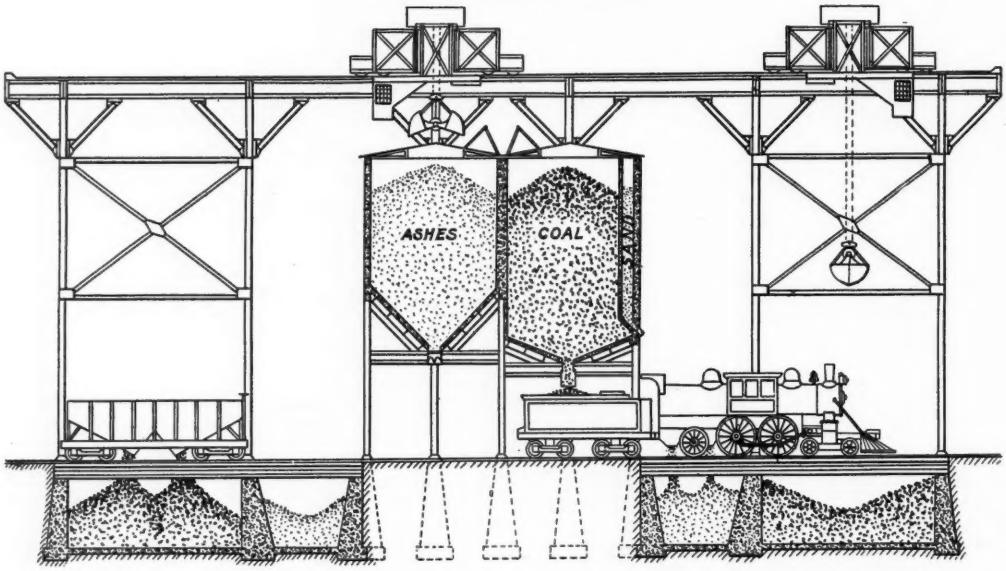

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If You Sell to Railroads

This item will interest you

¶ Quite recently a railway official (subscriber) read an article in the RAILWAY MASTER MECHANIC, describing how to make a machine for railroad shops. The article was illustrated with working drawings. The official tore out the page, wrote on one corner "MAKE THIS" and sent it to his shop superintendent. The machine was made from the drawings.

¶ Another railway official (M. M.) wrote us as follows last month:—"In looking over my July, 1907, copy of the RAILWAY MASTER MECHANIC I notice advertising pages 83, 84, 85 and 86 have been torn from the copy in my possession, and before charging anyone with this malicious act I would like to ascertain if pages were removed before being forwarded to me."

¶ These facts show why the RAILWAY MASTER MECHANIC is the best advertising medium to sell appliances and devices to railroads. Its readers look forward to it and have confidence in it, and they are the officials who operate the great systems. They are the men who say what equipment shall be bought.

¶ The RAILWAY MASTER MECHANIC is a railroad magazine for railroad officials; practical, though technical; clean, clear cut and closer to the motive power department of railways than any other.

Write us for sample copy and advertising rates.

Railway Master Mechanic

315 Dearborn St., Chicago, Ill.

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¶ Because it is the only complete and correct directory of railway officials and is published every month in the year.

¶ It is recognized by railway officials as the best List, because it comes every 30 days and gives them just the information they are looking for down to date.

¶ Manufacturers of railroad supplies and equipment advertise in the Red List because the railway officials of every department consult its columns when they are looking for supplies of any kind.

¶ The system of classifying and indexing manufacturers and supplies in the Red List is so complete and comprehensive that no advertisement, however small, is lost, and practically everything bought by a railroad is found therein; not only this, but the fact that an advertiser may and does list everything he sells, makes it invaluable to any one seeking railroad business, as well as the railroad official.

¶ If you are not in the Red List you ought to be and we can prove it. Give us a chance to do it.

The Railway List Company

315 Dearborn Street

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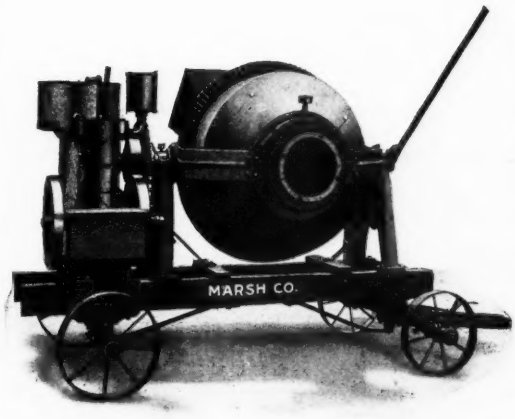
MARSH MIXERS ARE BEST



¶ The officers of this company are the same who sold 3000 mixers.

¶ In doing this we met more than 10,000 buyers.

¶ The experienced advice of these *practical men*—contractors, engineers and architects—gave us a world of information on which to base a new mixer.

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To avoid all the faults.
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To incorporate new improvements, which you, if one of our former customers, may have suggested.

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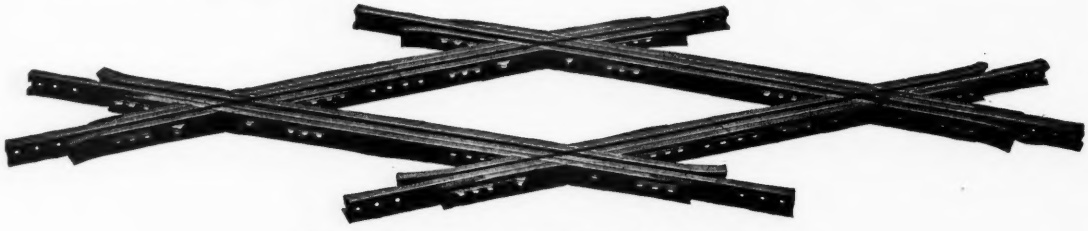

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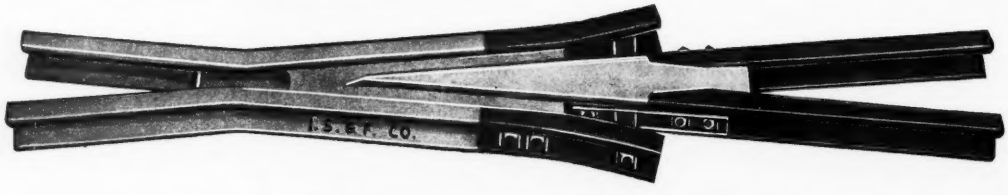

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